ALAGAPPA UNIVERSITY

[Accredited with 'A+' Grade by NAAC (CGPA:3.64) in the Third Cycle
and Graded as Category–I University by MHRD-UGC]

(A State University Established by the Government of Tamil Nadu)

KARAIKUDI – 630 003



Directorate of Distance Education

MA [History]

IV - Semester

321 43

ENVIRONMENTAL HISTORY

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E-28, Sector-8, Noida - 201301 (UP)
Phone: 0120-4078900 • Fax: 0120-4078999
Regd. Office: A-27, 2nd Floor, Mohan Co-operative Industrial Estate, New Delhi 1100 44
• Website: www.vikaspublishing.com • Email: helpline@vikaspublishing.com

Work Order No. AU/DDE/DE12-16/Printing of Course Material/2020 Dated 28.02.2020 Copies - 500

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Environmental History

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INTRODUCTION

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The environment is very important to people because it directly influences their lives. People depend largely on the environment for survival. The environment comprises the relationship between people, animals, plants, and even non-living things. It is important to study the environment and learn how to conserve it especially now that technology is beginning to ruin the natural resources and the ecosystem.

Awareness about global issues is now being spread through international conferences so that immediate solutions can be applied. The issues may range from dynamite fishing to global warming, and forest denudation to mining. With rapid urbanization and technological advancement, there is a need to study each step that may alter the environment so that the natural ecosystem may still be protected or replaced by a better one.

The subject of environmental history covers a gamut of topics including the study of meaning and role of eco-system, the importance of forests and environmental education, the evaluation of different kinds of environmental threats and the environmental protection measures in the form of legislations as well as movements.

This book, *Environmental History*, has been designed keeping in mind the self-instruction mode (SIM) format and follows a simple pattern, wherein each unit of the book begins with the Introduction followed by the Objectives for the topic. The content is then presented in a simple and easy-to-understand manner and is interspersed with Check Your Progress questions to reinforce the student's understanding of the topic. A list of Self-Assessment Questions and Exercises is also provided at the end of each unit. The Summary and Key Words further act as useful tools for students and are meant for effective recapitulation of the text.

BLOCK I
DEFINITION OF ECO AND ITS ROLE

UNIT 1 INTRODUCTION TO ECOSYSTEM AND ECOLOGY

Structure

1.0 INTRODUCTION

The biological community that occurs in some locale, and the physical and chemical factors that make up its non-living or abiotic environment make an ecosystem. Pond, forest, grassland, estuary are some of the examples of ecosystem. Though the boundaries such as in case of a pond appear, they are actually not marked in any objective way. We define the boundaries of an ecosystem in order to carry out a thorough study of it. The study of ecosystems chiefly include the study of some processes that connect the biotic or living components to the abiotic or non-living ones. Basically, ecosystems are categorised under two categories, natural and artificial ecosystems. Air, water, land, energy, etc., are ecosystem resources. Humans have managed to practice agriculture, build means of transportation, keep animals, set up industries, etc. Nonetheless, the hunger to use and explore the natural ecosystem seems endless. This calls for sustainable development, i.e., making progress keeping in mind the welfare of the future generation. Ecologists are always eager in studying the flow of energy in an ecosystem. Energy enters ecosystems in the form of light from sun and is then used in the process of photosynthesis by plants. It passes through the ecosystem with changing forms as organisms metabolize, produce waste, eat one another and finally die and decompose. In this unit, you will learn about the definition and scope of ecosystem, further, in this unit we will study about the ecological succession which is the process

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of changing of ecosystems over a period of time. Also the inter-relationship between civilization and ecology has been discussed later in the unit.

1.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the meaning, types and resources of ecosystem
- Explain the bondage between civilization and ecology
- Discuss the concept of environment

1.2 ECO-SYSTEM: DEFINITION AND SCOPE

Before, learning about the eco-system, it is important to learn some basic terms. An organism is a form of life. A wide range and variety of organisms are present on earth from the single-celled amoeba to huge sharks, from microscopic blue-green algae to massive banyan trees. It includes all plants and animals.

Species

Group of organisms that resemble one another in appearance, behaviour, chemistry and genetic structure form a species. Organisms of the same species can breed with one another and produce fertile offspring under natural conditions. For instance, all human beings (Homo sapiens) resemble one another in their body structure, body systems and they all have similar genetic structure. They are thus grouped together under the species and sapiens.

Population

Population is a group of individuals of the same species occupying a given area at a given time. For example, the Asiatic lions in the Gir National Park, Gujarat, make a population. Group of individual organisms of the same species living within an area is called population.

Communities

Groups of various species occupying a particular area and interacting with each other make up a community. For instance, when we say 'the community of the Gir National Park', we refer to the lion population, the deer population, the cattle population, the grass population and populations of all kinds of life forms present there. Thus, community comprises several species interacting with each other. Any assemblage of populations living in a prescribed area or physical habitat that has characteristics in addition to its individual and population components can be called a community.

Cycles

The circulation of the chemical elements in the biosphere, from the environment to organisms and back to the environment, is called cycle.

Food Chain

The transfer of food energy from its source in plants through a series of organisms where eating and being eaten is repeated a number of times is called food chain.

Carrying Capacity

The maximum population of a particular species that a given habitat can support over a given period of time is known as the carrying capacity of the habitat.

Ecosystem

An ecosystem is a community of organisms involved in a dynamic network of biological, chemical and physical interactions among themselves and with the non-living components. Such interactions sustain the system and allow it to respond to changing conditions. Thus, an ecosystem includes the communities, the non-living components and their interactions. The Gir ecosystem will thus include the various life forms found in the park (the community) and also the non-living components of the park like the soil, rocks and water and even the solar energy that is captured by the plants.

The sum total of all the ecosystems on planet Earth is called the biosphere, which includes all living organisms on earth, interacting with the physical environment as a whole, to maintain a steady-state ecosystem.

The community of organisms and populations that are interacting with one another and with the chemical and physical components of their environment is called 'ecosystem'.

The term ecosystem was first proposed by A.G. Tansley (1935) who defined ecosystem as follows: 'Ecosystem is defined as a self-sustained community of plants and animals existing in its own environment.'

Odum (1971) defined ecosystem as any unit that includes all the organisms in a given area interacting with the physical environment, so that a flow of energy gives rise to a clearly defined tropic structure, biotic diversity and material cycles within the system.

Michael Allaby (1983) defined ecosystem as a community of interdependent organisms together with the environment.

The term ecosystem is made up of two words: eco and system. Eco means ecological sphere or a region of space where living things can exist, while system mean interacting organisms living in a particular habitat (living space). Thus, the system resulting from the integration of all the living and non-living factors is called ecosystem.

An ecosystem may be defined as a dynamic entity composed of a biological community and its associated abiotic environment. Often, the dynamic interactions that occur within an ecosystem are numerous and complex. Ecosystems are always undergoing alterations in their biotic and abiotic components. Some of these alterations first begin with a change in the state of one component of the ecosystem, which then cascades and sometimes, amplifies into other components because of relationships.

Thermodynamically, a system is any part of the universe separated from the rest by a well-defined boundary. Likewise, a living organism has a boundary, the skin.

Thermodynamically, systems can be of three types:

- **Isolated system:** There is neither an exchange of energy nor matter with the environment.
- **Closed system:** There is an exchange of energy but not matter.
- **Open system:** There is an exchange of both energy and matter.

Open systems are not in thermodynamic equilibrium but in a dynamic steady state. Living systems are considered to be open.

In case of an ecosystem, the boundary is not rigidly defined. The ecological system or ecosystem is defined as a system where the biotic community (living organisms) and the non-biotic (non-living organisms) environment function together as one complete unit. Thus, an ecosystem includes both the living organisms and their non-living counterparts, the environment, each influencing the characteristics of the other and both are necessary for the survival and maintenance of life. An ecosystem has both structure and function. The structure tells about the diversity of species, as function involves the flow of energy and cycling of materials through the structural components. The earth as a whole, is thus a vast ecosystem and the portion of the earth in which the biotic components, i.e., the living matters are present is called 'biosphere' or 'ecosphere'. Relative to the volume of the earth, the biosphere is only a very thin surface layer that extends from 11,000 metres below sea level to 15,000 metres above.

Types of Ecosystem

Ecosystem is of two types: (1) Natural ecosystems (2) Artificial ecosystems.

Natural ecosystems: Ecosystems like ponds, lakes, oceans, forests, grasslands and deserts, which are self-regulating systems, without much direct human interferences or manipulations are called natural ecosystems. The natural ecosystem is thus, of two types: (*a*) terrestrial ecosystem (land based ecosystem) (*b*) aquatic ecosystem (water-based ecosystem).

Artificial ecosystems: The town, city and agricultural ecosystems are man-made ecosystems and are therefore, called artificial ecosystems.

Ecosystem Resources

For many years, Indian villagers have been dependent on forests for fuel-wood to cook food. Deforestation was not vehement when the population was less. However, with growing needs of the ever-increasing population, the situation has changed over the last few decades. Forests and the animals they sheltered have disappeared.

The disruption of this ecosystem has negatively affected the social system. Increase in the human population, deforestation, fuel shortage, decreased food production have adversely affected our ecosystem. Several human activities have impacted the ecosystems and its components in a way that achieving sustainability has become a distant reality.

Development is conventionally reconciled with the economists' view of maximizing wealth for better quality of life for the people. The notion of economic development was challenged when the ill effects of overexploitation surfaced and paved way for sustainable development as a cherished goal that rests on mutually reinforcing relationship between ecology, economic development and social justice.

Sustainable development can be defined as meeting present needs without compromising the ability of future generations to meet their needs. It is about leaving a cleaner earth for the future generations. Ecologically sustainable development is about keeping ecosystems healthy. It is about interacting with ecosystems in ways that allow them to maintain sufficient functional integrity to continue providing humans and all other creatures in the ecosystem the food, water, shelter and other resources that they need.

The sustainability of our planet depends on the respect we show to the ecological systems. On this rests the well-being of all organisms including the human race. Of late, ecosystems have been affected by: climate change; large-scale shifts in the ranges of species, timing of the seasons and animal migration; deeply stressed coastal areas; threat to certain important benefits provided by ecosystems; frequency and aggressiveness of disasters like tsunami. Natural ecosystems benefit humans by providing clean drinking water, and processes that help decompose dead plants and animals.

Land

The delineable part of the earth not covered by water is known as land. Land resources provide various functions or services including provisioning, regulating and supporting. However, the quality of the services reached its threshold as communities started exploiting land resources in the name of meeting their own needs. It is important to note that the renewal of land resources is a slow process.

The rate of degradation of land is much faster than the natural rate of generation. This means that land that is lost due to degradation will not be naturally replaced within a human time frame. This will lead to a loss of opportunities for the

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future generations. Deforestation, farming, damming of rivers, industrialization, mining, urbanization, etc., have seriously stressed land resources.

Recent studies conducted worldwide show that land resources have been overexploited by man. The traditional land resource management is no longer appropriate and technology is not always available or affordable. Figure 1.1 provides a snapshot of the causes of land resource degradation of the world.

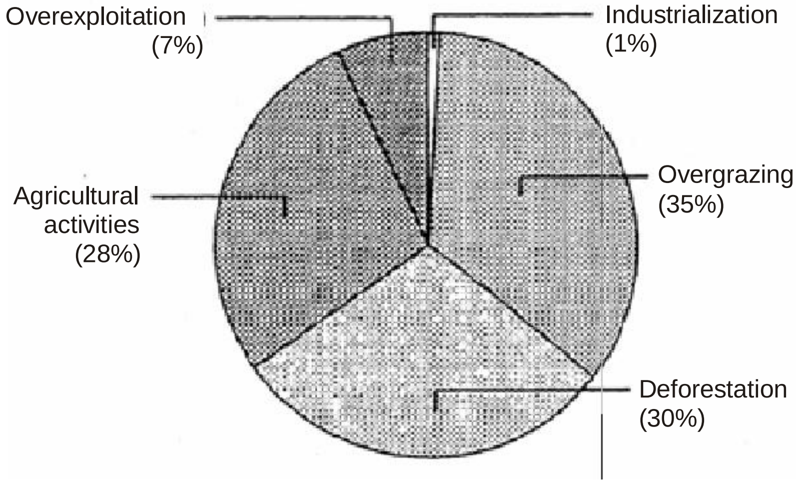


Fig 1.1 *Causes of Land Resource Degradation*

Source: http://www.env.go.jp/en/wpaper/1996/eae250008000002.gif

Degradation of land resources has resulted in serious variance in the energy balance. The aftermath of this has been made evident through the erratic change in the climate patterns and has posed an alarming threat of food insecurity for the growing population. The need of the hour is to promote the role of ecosystem facilitators rather than exploiters, charged with the responsibility of safeguarding the rights of unborn generations and of conserving land as the basis of the global ecosystem.

Water

After air, no other ecosystem resource holds greater significance than water. Water is a fundamental resource for development and is vital for the survival, health and dignity of human population. About 97.5 per cent of global water resource is saline in nature and found in the seas and oceans. The other 2.5 per cent of water resources provide fresh water to support 86 per cent of the world's population through glaciers, groundwater, permafrost and surface and atmospheric water. Figure 1.2 provides a comparison of worldwide water resource availability over a range of thirty years.

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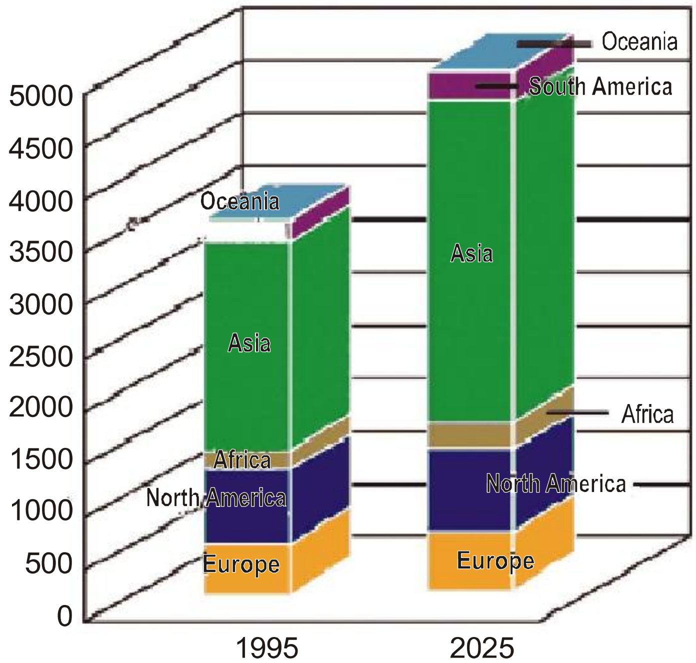


Fig 1.2 *Comparison of Water Availability*

Source: http://www.mlit.go.jp/english/2006/c_l_and_w_bureau/01_worldwater/images/c_001_2_zu.gif

The freshwater reserves throughout the world are rapidly declining. An estimated 3 billion people will be living in water poverty by 2025. Urbanization, overpopulation and wastage of groundwater, contribute towards an increase in per capita domestic consumption. As a result, India, China, Africa and Europe will face acute shortage of freshwater by 2025. India will face acute scarcity of water by 2050.

Sustainability of water resources in India is fast becoming a necessity. The increasing population and the high rate of development have led to an increase in pollution, over-exploitation and degradation of the environment. Weak government policies and economic incentives have led to inappropriate use of water resources in the last few years. Management of water resources should be carried out using a holistic approach that addresses the pressures arising from various sources such as the agricultural, industrial and domestic sectors.

Air

Understanding the relationship between air pollution and ecosystem services is vital for achieving sustainable development of the communities. Air is a precious resource that supplies us with oxygen, which is essential for us. Air quality primarily influences the atmosphere in which people live and breathe.

Several researches conducted globally on air pollution suggest that developing nations are the most affected by it. Air pollutants such as nitrogen

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oxides (NOx), ammonia (NH3) and sulphur dioxide (SO2) have major effect on the ecosystem services. These range from substantial reductions in food provisioning due to crop yield impacts to changes in the ecosystem functioning. It is likely that these impacts represent a barrier to providing sufficient crop growth to reduce hunger and maintaining diverse natural ecosystems.

Energy

Understanding the links between energy, poverty and ecosystem services is important for attaining sustainable development. Increased access to energy for the poorest part of the world's population will help in holistic, sustainable development. The current energy use of the poor is neither sufficient to attain the sustainable development nor is it sustainable in terms of maintaining important ecosystem services that can facilitate a transition out of poverty. Meeting the basic energy needs of the poor with minimized impacts on the ecosystem services needed for other aspects of sustainable development attainment such as food production and livelihood support is thus vital.

Other Resources

Another important ecosystem resource which is important to discuss in the present scenario is biodiversity. Biodiversity provides both tangible and intangible benefits like food, fodder, fiber, fuel, climate regulation, flood and drought control, nutrient recycling, cultural and recreational benefits.

Development processes like industrialization and urbanization have brought about loss and degradation of biodiversity throughout the world. Today, several species of organisms, plants and animals are at the threshold of extinction and their conservation is the need of the hour. Identifying the importance of biodiversity, attempts are being made through following various approaches and different strategies, to conserve it. One of the prominent organizations in this area is International Union for Conservation of Nature (IUCN) which has been doing remarkable work in conservation of endangered species.

A system is an arrangement of matter related to form a whole (unit). The living organisms (biotic community) of an area and their non-living environment function together as one unit called ecological system or ecosystem. The term ecosystem was first introduced in 1935. In the ecosystem, the living organisms and its environment each influences the properties of the other and both are necessary for the survival and maintenance of life. Some examples of natural ecosystems are ponds, lakes, oceans, grasslands, forests, deserts, and so on. The largest ecosystem of the earth is the biosphere, which is self-sufficient and balanced. Each ecosystem has two components, i.e., biotic and abiotic substances. In short, ecosystem can be described as 'Life Support System'.

Components of Ecosystem

Given below are the components of an ecosystem:

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***Biosphere*—**The biosphere is the biological component of earth systems. It consists of all the living organisms on earth, along with the dead organic matter produced by them. The concept was introduced by geologist Eduard Suess in 1875 and is central to many significant disciplines. According to him it meant 'the place on Earth's surface where life dwells'.

***Biome*—**Another important concept that finds place in this context is that of a biome. A biome is nothing but a large area comprising similar flora, fauna and microorganisms. Biomes categorize the biological communities on the earth according to similarities found in the dominant vegetation, climate, geographic location and various other characteristics. Each of these categories contains species, which have adapted to varying conditions of water, heat and soil. A biome consists of many similar ecosystems throughout the world grouped together. Ecologists have identified at least five major categories of biomes namely, aquatic, desert, forests, grasslands and tundra. A biome is characterized by a unique set of abiotic factors, particularly climate, and encompasses an ecological community.
Regional ecosystems are referred as biomes, while the largest of all the possible ecosystems is called a biosphere. Figure 1.3 provides the levels of organization in ecology.

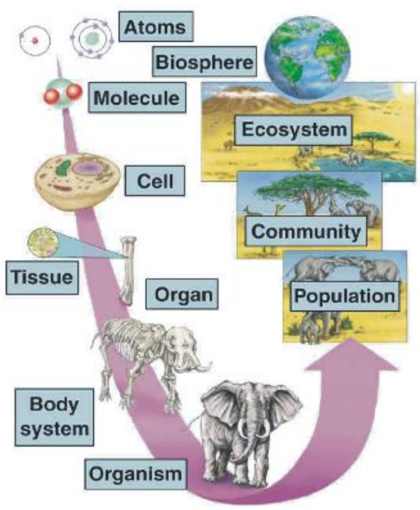


Fig 1.3 *Levels of Organization in Ecology*

Source: http://www.ux1.eiu.edu/~cfruf/images/bio3002/els_le2.jpg

Structure of an Ecosystem

However, all ecosystems consist of components that can be categorized into two main types, namely, abiotic components, consisting of chemical substances and physical conditions that support life in the ecosystem, and biotic components, which include all living organisms. There is also some source of energy and interaction that takes place in all ecosystems. Figure 1.4 illustrates the components of an ecosystem.

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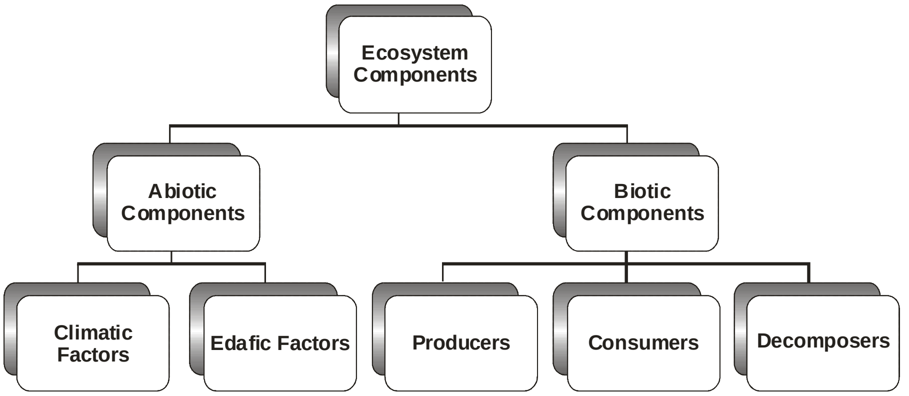


Fig 1.4 *Components of an Ecosystem*

1. **Abiotic components:** Abiotic components that are responsible for creating the physical environment of an ecosystem consist mainly of elements like energy, inorganic elements and compounds, dead organic matter and climate.
2. **Biotic components:** The biotic components of an ecosystem include plants, animals and microbes, i.e., the complete living community. The biotic components can be further classified to include **autotrophs** or producers, **heterotrophs** or consumers and **saptotrophs** or reducers. Heterotrophs or consumers obtain energy and nutrients by feeding directly or indirectly on the autotrophs. Animals are the primary heterotrophs. Plants and animals provide organic matter to the soil by shedding skins as well as through death.

Saprotrophs or decomposers are those organisms that consume this organic matter, which is called **detritus**. The organic matter that is consumed by these organisms ultimately transforms back into inorganic nutrients in the soil. The plants can utilize these nutrients to produce organic compounds.

Autotrophs: Green plants are generally considered as the autotrophs.

The autotrophic components include green plants, photosynthetic bacteria, chemosynthetic microbes, etc. The autotrophic components are known as **producers**.

The main function of these is to absorb energy from non-living organisms and make it available to all living organisms. The main producers are, of course green plants. These plants possess a green pigment called 'chlorophyll', which transduces solar energy. Such producers absorb solar energy through the light trapping pigments, chlorophylls and convert it to chemical energy with the help of inorganic substances such as water and carbon dioxide, as well as organic substances such as enzymes.

Such a process is known as 'photosynthesis', carbon assimilation or primary biological productivity. These autotrophs are known as 'photo-autotrophs', as they utilize light energy. The biochemical formula that describes photosynthesis is:

$$6CO_2 + 6H_2O + \text{Solar Energy} \xrightarrow{\text{Chlorophyll}} C_6H_{12}O_6 + O_2$$

Lower Energy Higher Energy

The oxygen thus evolved, is used for respiration by the living organisms.

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The other type of autotrophs called 'chemo-autotrophs', use the energy generated in an oxidation–reduction process. The microorganisms like *beggiatoa* and sulphur bacteria are some examples of chemo-autotrophs. However, the importance of chemo-autotrophs as producers is minimal in an eco-system.

Heterotrophs

(Hetero means '*different*', trophic means '*nourishing*')

Heterotrophic components are the living organisms that are unable to prepare their own food like autotrophs, but consume or decompose the complex food material prepared by the autotrophs or producers. Heterotrophs, are thus of two types:

(*a*) Consumers

(*b*) Decomposers and transformers

(a) Consumers

Consumers are the living organisms that consume food prepared by producers. On the basis of dependency on food habits, consumers can be of four types:

(*i*) Primary consumers, (*ii*) Secondary consumers, (*iii*) Tertiary consumers, (*iv*) Decomposes and transformers.

(*i*) *Primary consumers*: Those that feed directly on green plants and are purely herbivorous animals, e.g., cow, dove, buffalo, deer, elephants, and insects like butterfly.

(*ii*) *Secondary consumers*: Those that feed on primary consumers and can be purely carnivorous (flesh eating) as well as omnivorous (plants and flesh eating), e.g., small birds, toad, lizard, small fish.

(*iii*) *Tertiary consumers*: Those that feed on secondary consumers and are the top carnivores. They can feed on primary consumers also. Thus, the tertiary consumers feed on other carnivores, omnivorous as well as herbivorous animals, e.g., lion, tiger, hawk, vulture, snake, peacock, large fish, etc.

(b) Decomposers and Transformers

Decomposers are also heterotrophic organisms, but they depend upon dead organisms for their food. They are chiefly microorganisms like bacteria, fungi, etc. Some invertebrate animals like *protozoa* (*amoeba*, *entamoeba*, *euglena*), as well as earthworms, decompose dead organisms to derive food from them and can therefore, be classified as decomposers. The decomposers attack the dead bodies of producers and consumers, degrading the complex organic substances

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like cellulose, semicellulose, proteins and fats into simple substances. The transformers then convert these simple organic substances into the inorganic form, suitable for reuse by the producers. The decomposers and transformers are very important microorganisms which maintain the dynamic equilibrium in the eco-system.

Functions of an Ecosystem

An ecosystem has got two main functions, which are as follows:

(1) Productive

(2) Distributive

In its productive function, it produces energy, which in its distributive function is further passed on to the members in the ecosystem. Autotrophs (producer) produce energy through chlorophyll by trapping solar energy through a process called photosynthesis. These autotrophs are then consumed by heterotrophs (consumer) and hence energy is passed on from producer to consumer.

Energy Flow in the Ecosystem

The transformation of energy between the different components of an ecosystem is known as 'energy flow'. This is very important, as it determines the density and diversity of organisms as well as their development and functional status. The energy flow in an ecosystem is always uni-directional in nature.

To prepare food and to store it in the form of chemical energy, green plants, with the help of their green pigments known as 'chlorophyll', trap solar energy and convert carbon dioxide (CO2) and water (H2O) into complex food materials with the help of other nutrients. This is done through the process of photosynthesis and is referred to as primary production.

The total amount of solar energy converted into chemical energy by green plants is called Gross Primary Production (GPP). Some part of the gross primary production (GPP) is utilized by plants for their various metabolic activities, (mainly respiration [MA]) and the remainder is called the Net Primary Production (NPP).

Thus,

GPP = NPP + MA

When,

(*i*) GPP = MA, there is no change in energy content (NPP = 0).

(*ii*) GPP < MA, NPP becomes negative, *i.e.*, bio-mass undergoes degradation.

(*iii*) GPP > MA, NPP becomes positive, *i.e.*, accumulation of biomass.

The grains, straws and roots, harvested after a growing season, comprise the NPP. Primary production is of special importance in ecology, since it is the energy fixed by plants by converting solar energy into chemical energy of food stuff that support life in other trophic levels.

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When herbivores consume autotrophic plants as food, part of the food is assimilated and the rest is ingested. Some parts of the assimilated food, the potential energy stored as chemical energy of food, get oxidized through respiration, the carbon-carbon bonds are broken and carbon combines with oxygen to form carbon dioxide, releasing kinetic energy. Some parts of the energy is used by the organism to do work and the rest dissipates as heat.

$$C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O + \text{Kinetic energy}$$

The efficiency of energy utilization varies from organism to organism and within similar organisms it varies with the physical structure of the organism and its age. The remaining part of the assimilated food (energy) is stored in somatic and reproductive tissues for growth and reproduction.

The production of organic matter by heterotrophic organisms is known as 'Secondary Production'. The total quantity of plant material ingested and stored (assimilated) in the body of heterotrophic organisms (herbivore) is known as 'Gross Secondary Production' and the remaining part of the assimilated food (energy) after metabolic processes (mainly respiration), is known as 'Net Secondary Production'. When herbivores are consumed by carnivores (secondary consumers), further degradation of energy occurs.

Similarly, when carnivores (secondary consumers) are consumed by top carnivores (tertiary consumers) again, energy is degraded further. Thus, at each level of the system there is degradation of energy.

The decomposers ultimately, get food and energy by decomposing the dead organisms of all the trophic levels. The energy flow through various components of ecosystem can be depicted through Figures 1.5 and 1.6

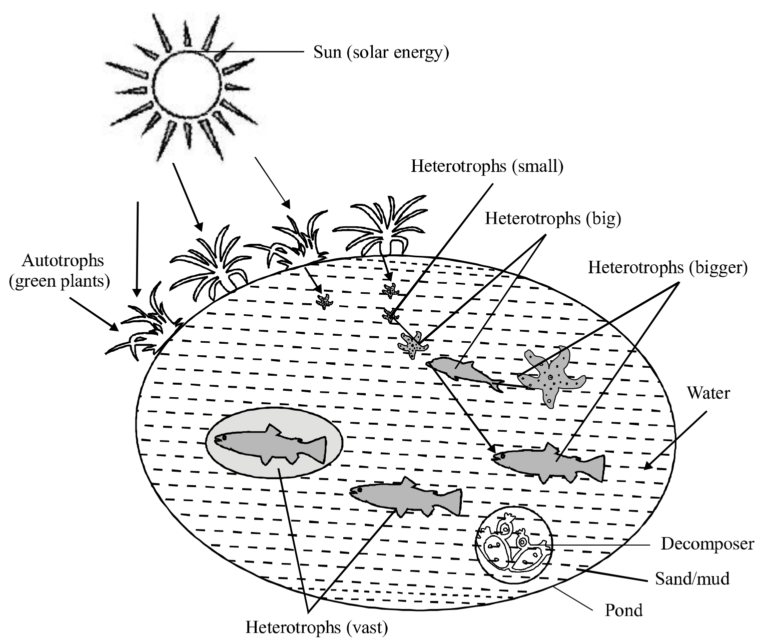


Fig 1.5 *Passage of Energy in Ecosystem Ecosystems*

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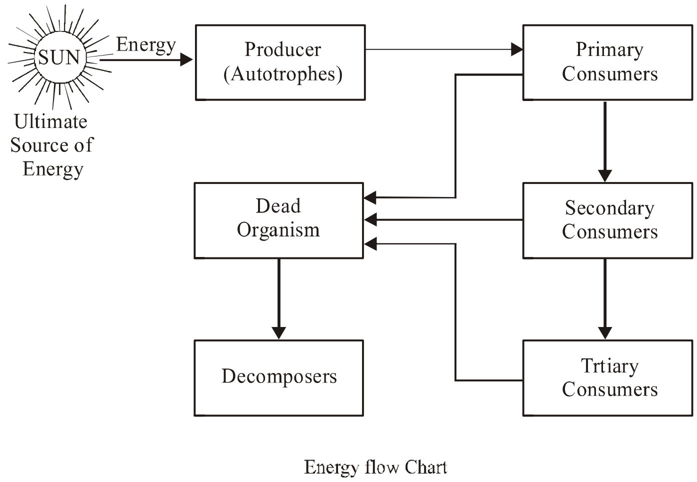


Fig 1.6 *Energy Flow Chart*

Ecological Succession

Ecological succession is the gradual process by which ecosystems change over time. Habitats are constantly changing. To give you an example, a bare patch of ground will not stay bare for long. It will be quickly colonized by a variety of plants, ants, pests and other living creatures. In the process of succession, the species present in an area will gradually change. Succession occurs because the environmental conditions prevalent in a particular place change over time. Each species is adapted to thrive and compete best against other species under a very specific set of environmental conditions. If these conditions change, then the existing species will be replaced by a new set of species which are better adapted to the new conditions.

Ecological succession is the observed process of modification in the species structure of an ecological community over time. Within a community, some species may become less abundant over time, or they may even disappear from the ecosystem altogether. Similarly, other species within the community may become more abundant, or new species may invade to the community from adjacent ecosystems.

There are specific environmental conditions under which species will grow and reproduce most optimally. Given an ecosystem's set of environmental conditions, those species that can best survive and grow and produce the most viable offspring will, in all probability, become the most abundant living things. As long as the ecosystem's set of environmental conditions remains unchanged, the species that are most suited to those conditions will flourish. The cause behind changes in an ecosystem is the impact that species have upon the environment. In the process of living, organisms alter their environment over a period of time. While the original environment may have been ideal for a certain species of plant or animal, the new

environment is often optimal for some other species. Under the modified conditions, the erstwhile dominant species are likely to dwindle and another species may become ascendant.

Ecological successions can be short-term, usually due to changes in season. For instance in summer, the open ground in your locality is dry and may be home to rodents, ants and other small insects. But in the rainy season, it gets filled with water and becomes home to another set of plants and animals—algae, mosquitoes, small fish and so on. Once the rains end, the ground may again turn dry and the original species may return to their habitat. Ecological succession may also take place when conditions of an environment are altered suddenly and drastically. Floods, forest fires, wind storms and human activities like agriculture all greatly modify the conditions of an environment. These devastating forces may also eradicate some species and thus introduce non-reversible changes in the dynamics of the community, kick-starting a struggle for dominance among the species that have survived.

Check Your Progress

1. What do you mean by species?
2. What is food chain?
3. What is an ecosystem?
4. Name the factors which have adversely affected our ecosystem.
5. What is sustainable development?
6. How do natural ecosystems benefit humans?

1.3 BONDAGE BETWEEN CIVILIZATION AND ECOLOGY

Ecosystems are strongly affected by human activities which are a simple manifestation of society where human beings live. In a simple human–ecosystem interaction, the ecosystem provides services to the human social system by the way of moving materials, energy and information to meet people's needs. The ecosystem resources, both natural and artificial, play a vital role in the discharge of ecosystem services of provisioning, regulating, supporting and recreating. Like ecosystems, human social system affects the ecosystem through use of ecosystem resources for their survival needs. This relationship has been displayed in Figure 1.7.

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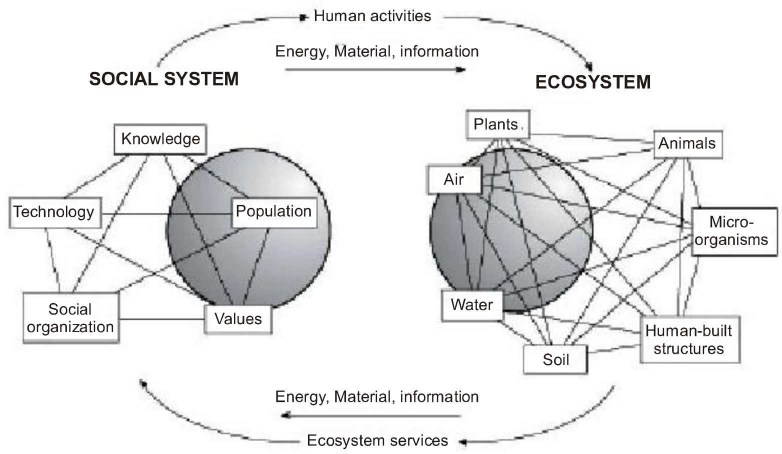


Fig 1.7 *Human–Ecosystem Interaction*

Source: http://www.gerrymarten.com/human-ecology/images/01-1-english.jpg

Human-ecosystem interaction may be explained through the concepts of common property resources, coexistence and adaptive development.

Common Property Resources

Common Property Resources (CPR) include all such resources which are meant for common use of the villagers but not for individual possession. These resources are an indispensable aspect of the social and institutional arrangements made to meet the everyday requirements of village communities. They are particularly important to the landless, the agricultural labours and rural artisans. Usually, common property resources are identified by three factors—access, common use and communal purpose. These two characteristics distinguish it from a private good, which is subject to exclusive use and possession by individuals. These resources are community pastures and forests, wastelands, common dumping and threshing grounds, watershed drainages, village ponds, rivers and other common pool water bodies.

CPRs perform a major role as a life support system. In developing countries like India, CPRs are an important component of the resource base of both the rural as well as urban communities. They contribute to the production and consumption needs of the people in these communities, as well as beyond. When properly managed, CPRs ensure the sustainability of agro-ecological systems providing basic needs and sustenance for the poor.

Nearly everywhere, common property resources have been steadily reduced in extent and importance in modern times. Activities like encroachment as well as privatization and government appropriation are the main processes that have taken resources out of communal control. Increasing pressures on what is left have generally led to its progressive degradation, encouraging further expropriation.

The need of the hour is therefore to resort to a more successful common property resources management that has:

- Social groups with rights to a clearly defined resource.
- Ability to exclude others from using the resource.
- Set of use rules that limit the seasonality, extent, or ways in which the resource is extracted by individuals.
- Capacity to monitor use and enforce rules.

Coexistence

Coexistence is a common architectural feature of ecosystems where autotrophs and heterotrophs exist together in a mutually interdependent, compulsory relationship that ensures the flow of energy and the constant recycling of vital chemical nutrients through the ecosystem. Constant energy and nutrient flows are important if the system has to carry on as a self-sustaining collection of components and relationships within a certain physical environment.

Coexistence in relation to human–ecosystem interaction could be used to explain the respectful and non-violent relationship between human beings and different species living in a given place at any given time.

Adaptive Development

Understanding the concept of adaptive development paves way for understanding the notion of resilience and its relationship with sustainable development. The capability of an ecosystem to endure disturbances like storms, fire and pollution, without changing its form, is known as ecosystem resilience. If a resilient ecosystem is damaged, it has the ability to repair itself. In a resilient ecosystem, the procedure of repairing facilitates renewal and innovation. Without resilience, ecosystems become more prone to the effects of disturbances, which could have previously been absorbed.

Clean and clear lakes can turn into dirty, oxygen-depleted pools; grasslands can be converted into shrub-deserts, and coral reefs into algae-covered rubble. All these are a result of a combination of disturbance patterns caused by human alteration in nature, and due to reduced social and ecological resilience of ecosystems. Coral reefs, mangrove forests and other coastal wetlands shelter human settlements from coastal storms. Forests and wetlands help in absorbing floodwaters. Sadly, our activities have depleted resilience in many natural systems to such an extent that their ability to protect us from disturbances has declined. Furthermore, the resilience of many social systems to natural calamities has been decreased as the increase in the human population growth has forced people to settle down and conduct economic activities in vulnerable areas.

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Ecological Balance or Ecosystem Stability

Ecological balance or ecosystem stability implies a balance between the production and consumption of each component in the ecosystem. According to T.D. Brock, 'Steady state condition in nature ecosystem is a time independent condition in which production and consumption of each constituent in the system is exactly balanced, the concentration of all constituents within the system remains constant, even though there occurs a continual change'.

There are a number of theories, mechanisms and models to explain the stability of ecosystem. The important ones are as follows:

(i) Theory of Diversity or Stability

If there is diversity of food webs, it will lead to an increase in the number of links in the food web and if community succession operates in an ecosystem, the stability will increase.

(ii) Homeostatic Mechanism

Inbuilt, self-regulating mechanism is known as homeostatic mechanism. If within an ecosystem the population of a species increases significantly, the result will be scarcity of food, leading to competition for food. Most species will die of starvation and the species population will be brought back to its original value and the stability will be restored.

(iii) Models

The equilibrium, as well as non-equilibrium model can explain stability. Thus, if the ecosystem is disturbed by external factors, it may quickly return to its original state by some adjustments, restoring the stability. However, if it does not return to its original state, the disordered arrangement might lead to cross-relationships and make the system stable.

Ecological Instability

When an ecosystem is unable to adjust to the environmental changes, it is said to be unstable. The instability occurs due to a number of natural and anthropogenic activities such as destruction of natural vegetation and animal species, partly or completely or by replacing them by other vegetations and animals, introduction of toxic substances like insecticides and pesticides and toxic gases like SO_2 and NO_2.

Importance of Ecology

During the past decades, due to rapid increase in technology and population, humans have far more influenced their own environment than any other ecosystem.

Some quoted examples of ecological crisis are as follows:

- *Permian*: Triassic extinction over 25 million years ago.

- *Cretaceous*: Tertiary extinction over 65 million years ago.
- Global warming related to greenhouse effect could involve flooding of the Asian deltas, multiplication of extreme weather phenomena and changes in the nature and quality of the food resources.
- Ozone layer hole issue
- Deforestation and desertification, resulting in disappearance of many species
- The nuclear meltdown at Chernobyl in 1986, caused the death of many people and animals due to cancer and caused mutation in large number of people and animals.

The study of ecology helps us to understand the various primitive factors responsible for the existence of life on earth. The survival and well-being depend entirely on the ecological relationships. Although, ecology is considered a branch of biology, ecology deals with many other branches of science, such as chemistry, physics, geology, geography, meteorology, pedology, etc. Thus, the study of ecology gives a reactive insight into the universe and helps to take proper care of the environment for overall survival.

Check Your Progress

7. What are Common Property Resources?
8. What do you mean by coexistence?
9. When is the ecosystem said to be unstable?

1.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Species is a group of organisms that resemble one another in appearance, behaviour, chemistry and genetic structure.
2. The transfer of food energy from its source in plants through a series of organisms where eating and being eaten is repeated a number of times is called food chain.
3. An ecosystem is a community of organisms involved in a dynamic network of biological, chemical and physical interactions among themselves and with the non-living components.
4. Increase in the human population, deforestation, fuel shortage, decreased food production have adversely affected our ecosystem.
5. Sustainable development can be defined as meeting present needs without compromising the ability of future generations to meet their needs. It is about leaving a cleaner earth for the future generations.

6. Natural ecosystems benefit humans by providing clean drinking water, and processes that help decompose dead plants and animals.
7. Common Property Resources (CPR) include all such resources which are meant for common use of the villagers but not for individual possession. These resources are an indispensable aspect of the social and institutional arrangements made to meet the everyday requirements of village communities.
8. Coexistence is a common architectural feature of ecosystems where autotrophs and heterotrophs exist together in a mutually interdependent, compulsory relationship that ensures the flow of energy and the constant recycling of vital chemical nutrients through the ecosystem.
9. When an ecosystem is unable to adjust to the environmental changes, it is said to be unstable.

1.5 SUMMARY

- Group of organisms that resemble one another in appearance, behaviour, chemistry and genetic structure form a species.
- Population is a group of individuals of the same species occupying a given area at a given time.
- Groups of various species occupying a particular area and interacting with each other make up a community.
- An ecosystem is a community of organisms involved in a dynamic network of biological, chemical and physical interactions among themselves and with the non-living components. Such interactions sustain the system and allow it to respond to changing conditions.
- The term ecosystem is made up of two words: eco and system. Eco means ecological sphere or a region of space where living things can exist, while system mean interacting organisms living in a particular habitat (living space).
- Sustainable development can be defined as meeting present needs without compromising the ability of future generations to meet their needs. It is about leaving a cleaner earth for the future generations. Ecologically sustainable development is about keeping ecosystems healthy.
- Land resources provide various functions or services including provisioning, regulating and supporting. Deforestation, farming, damming of rivers, industrialization, mining, urbanization, etc., have seriously stressed land resources.
- Understanding the relationship between air pollution and ecosystem services is vital for achieving sustainable development of the communities. Air is a precious resource that supplies us with oxygen.

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- Another important ecosystem resource which is important to discuss in the present scenario is biodiversity. Biodiversity provides both tangible and intangible benefits like food, fodder, fiber, fuel, climate regulation, flood and drought control, nutrient recycling, cultural and recreational benefits.
- Each ecosystem has two components, i.e., biotic and abiotic substances. In short, ecosystem can be described as 'Life Support System'.
- Regional ecosystems are referred as biomes, while the largest of all the possible ecosystems is called a biosphere.
- Abiotic components that are responsible for creating the physical environment of an ecosystem consist mainly of elements like energy, inorganic elements and compounds, dead organic matter and climate.
- The biotic components of an ecosystem include plants, animals and microbes, i.e., the complete living community. The biotic components can be further classified to include autotrophs or producers, heterotrophs or consumers and saptotrophs or reducers.
- The autotrophic components include green plants, photosynthetic bacteria, chemosynthetic microbes, etc. The autotrophic components are known as producers.
- Heterotrophic components are the living organisms that are unable to prepare their own food like autotrophs, but consume or decompose the complex food material prepared by the autotrophs or producers.
- The transformation of energy between the different components of an ecosystem is known as 'energy flow'. This is very important, as it determines the density and diversity of organisms as well as their development and functional status.
- Ecological succession is the gradual process by which ecosystems change over time.
- Ecosystems are strongly affected by human activities which are a simple manifestation of society where human beings live. In a simple human–ecosystem interaction, the ecosystem provides services to the human social system by the way of moving materials, energy and information to meet people's needs.
- Common Property Resources (CPR) include all such resources which are meant for common use of the villagers but not for individual possession. These resources are an indispensable aspect of the social and institutional arrangements made to meet the everyday requirements of village communities.
- Activities like encroachment as well as privatization and government appropriation are the main processes that have taken resources out of communal control.

- Understanding the concept of adaptive development paves way for understanding the notion of resilience and its relationship with sustainable development. The capability of an ecosystem to endure disturbances like storms, fire and pollution, without changing its form, is known as ecosystem resilience.
- Ecological balance or ecosystem stability implies a balance between the production and consumption of each component in the ecosystem.
- The study of ecology helps us to understand the various primitive factors responsible for the existence of life on earth. The survival and well-being depend entirely on the ecological relationships.

1.6 KEY WORDS

- **Ecosystem:** It is the biological community of interacting organisms and their physical environment.
- **Species:** It refers to a group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.
- **Sustainable development:** It refers to the economic development that is conducted without depletion of natural resources.
- **Biosphere:** It refers to the regions of the surface, atmosphere, and hydrosphere of the earth (or analogous parts of other planets) occupied by living organisms.
- **Environment:** It refers to the natural world, as a whole or in a particular geographical area, especially as affected by human activity.

1.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the types of ecosystem?
2. State the components of ecosystem.
3. What are the causes behind the reduction of common property resources?
4. Why is it important to study the ecology?

Long-Answer Questions

1. How has the disruption of ecosystem affected the social system? Explain.
2. ‘Degradation of land resources has resulted in serious variance in the energy balance.’ Elucidate the statement.
3. Describe the structure of an ecosystem.

1.8 FURTHER READINGS

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UNIT 2 ECOLOGICAL BALANCE

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Structure

2.0 INTRODUCTION

Ecological balance describes the equilibrium between living creatures and the environment they live in. For example, the process of photosynthesis taking place in plants contributes to building a good environment that balances the coexistence of all the organisms. Since humans have reasoning and thinking capability, they play an instrumental role in keeping the ecological balance due to which survival of all organisms is possible. Ecological balance makes sure that no species are being overused or exploited. Conservation of nature is the moral philosophy and conservation movement aimed at maintaining and restoring habitats, protecting species from extinction and biological diversity and improving ecosystem services. In modern times, evidence-based conservation tools are employed for conserving the natural resources. The goals for nature conservation are protecting habitat, preventing deforestation, mitigating overfishing and decreasing climate change. Moreover, conservation is involved with the study of earth's biological loss, understanding the causes behind the loss and creating solutions to restore the biodiversity. Today, various changes in earth's climate are happening due to global warming which is the result of greenhouse effect. The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases. Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, ozone and some artificial chemicals such as chlorofluorocarbons (CFCs). In this unit, we will study in detail about the balance of the ecosystem, conservation of nature and natural resources and the greenhouse effect.

2.1 OBJECTIVES

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After going through this unit, you will be able to:

- Describe the meaning and types of ecological factors
- State the relation between culture and climate
- Explain the meaning of conservation and various methods to conserve the natural resources
- Discuss the causes and effects of the greenhouse effect

2.2 NATURE'S BALANCE

Ecological balance or stability of the ecosystem implies a balance between the production and consumption of each component in the ecosystem. According to T.D. Brock, 'Steady state condition in natural ecosystem is a time independent condition in which production and consumption of each constituent in the system is exactly balanced, the concentration of all constituents within the system remains constant, even though there occurs a continual change.'

There are a number of theories, mechanisms and models to explain the stability of the ecosystem. The important ones are as follows:

(i) **Theory of diversity or stability:** If there is diversity of food webs, it will lead to an increase in number of links in the food web and if community succession operates in an ecosystem, the stability will increase.

(ii) **Homeostatic mechanism:** Inbuilt, self-regulating mechanism is known as homeostatic mechanism. If within an ecosystem the population of species increases significantly, the result will be scarcity of food, leading to competition for food. Most species will die of starvation and the species population will be brought back to its original value and the stability will be restored.

(iii) **Models:** The equilibrium, as well as non-equilibrium model can explain stability. Thus, if the ecosystem is disturbed by external factors, it may quickly return to its original state by some adjustments, restoring the stability. However, if it does not return to its original state, the disordered arrangement might lead to cross-relationships and make the system stable.

Issues Affecting Ecological Equilibrium: Ecological factors

In an ecosystem, a living organism is influenced by a large number of environmental factors. These environmental factors are known as ecological factors or eco-factors. These factors may be biotic (living) or abiotic (non-living). All the environmental

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factors bring marked distributional, structural and functional changes in organisms. To live, grow and carry out all its activities, an organism requires a harmonious relationship with its immediate environment. The differences in vegetation of a desert and a rain forest, fish in sweet water and saline water, animals in tropical countries and cold countries, clearly indicate the role of environmental factors in the distribution and survival of organisms in different eco-systems.

The organisms subjected to diurnal, seasonal, annual and cyclic relations of the environment, develop strategies to cope with these changes for their survival. Only those which are able to cope with the conditions, remain and those who cannot, become extinct.

The ecological factors can be classified into the following:

1. **Climatic factors:** (i) light (ii) temperature (iii) nature (iv) rainfall (v) wind (vi) humidity (vii) atmospheric gases (viii) pH

A variation in these factors affects the distribution and lifestyle of organisms.

2. **Topographic factors:** (i) altitude (ii) slope and direction of mountain chain and valleys.
3. **Edaphic factors:** Structure, formation and characteristics of different types of soils.
4. **Biotic factors:** Biotic factors are derived from the interactions between different species of life (intra-specific as well as inter-specific). The different species mentioned here are plants, micro-organisms and animals.
5. **Limiting factors:** Denote the amount of substance that is either least abundant or over abundant in relation to the need of the living organism.

Climatic factors

(i) Light

Light plays a vital role for both plants and animals. Sunlight is the ultimate source of energy for the biological world. Light is highly essential for photosynthesis, plays an important role in respiration and transpiration, regulates hormones in plants thereby modifying the shape and size and influences the growth and development of flowers, fruits, germination and distribution of plants. As far as animals are concerned, light influences reproduction and metabolism.

(ii) Heat

Like light, heat exerts a profound influence on the physiological and biochemical activities of organisms. Generally, organisms prefer to conduct their activities in a temperature region of 4°C to 45°C. The physiological effects of temperature are the mineral absorption in plants, water intake, growth, germination in plants and distribution, migration, hibernation and reproductive activities in animals. Both plants

and animals exhibit morphological, ecological and physiological adaptation to the variation in temperature. The biochemical effects are due to enzymes and hormonal changes and are related to the temperature.

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(iii) Water

Water is one of the most important materials necessary for life. All the physiological processes take place in water. The availability of water in an ecosystem affects the distribution, growth and other activities of its organisms.

(iv) Rainfall

Rainfall (precipitation) determines the type of vegetation in any region. Tropical regions support thick evergreen forests as it experiences heavy rainfall throughout the year. Grasslands are found in regions where there is heavy rainfall in summer and low rainfall in winter. Due to changes in vegetation, animals and birds in various regions also differ.

(v) Wind

Wind brings physical, anatomical and physiological changes to plants. Excessive transpiration due to wind leads to desiccation and death of apical meristems. Thus, the plants become dwarf, contain small leaves and more branches. On the mountains, due to the danger of uprooting, the vegetation is composed of species having prostrate growth, with long underground roots. This is known as growth of *rhizome* type.

(vi) Humidity

The physiological activities of organisms, like transpiration, absorption of water, etc., are greatly influenced by humidity. Thus, humidity plays an important role in the life of plants and animals.

(vii) Atmospheric gases

Gases like nitrogen, oxygen, carbon dioxide, water vapour and inert gases are essential for sustaining life. However, gases like sulphur dioxide (SO2), nitrogen dioxide (NO2), hydrogen sulphide (H2S) and smoke particles from the industries have a major influence on the environment and lead to various physiological changes in plants and animals.

(viii) pH

pH can be a deciding factor in aquatic ecosystem, as far as distribution of organisms is concerned. For aquatic animals as well as for organisms on land, the pH should not be too acidic or too alkaline. For every species, there is an optimum pH level at which they can survive. Large scale industrialization and the discharge of effluents into water bodies or the soil change the pH level to a great extent, endangering the lives of organisms.

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Topographic factors

The physical geographical factors are known as *topographic factors*. These factors include altitude, slope and direction of mountain chains and valleys. All these factors affect the climatic conditions of a place and thereby influence the distribution of organisms. With rise in altitude, there is progressive fall in temperature and as we go higher, with a decrease in temperature there is greater activity of the wind. A decrease in soil temperature reduces the absorption of water and nutrients by the plants. In higher altitudes, the atmospheric pressure and decreased concentration of oxygen affects animals, particularly mammals. The slope and direction of mountain chains have a pronounced effect on the amount of solar radiation, rainfall, wind velocity, temperature and on the whole, the climate of the area. This, in turn, affects vegetation patterns and thus, the distribution of animals.

Edaphic factors

Edaphic factors deal with the structure formation and characteristics of different types of soils.

Soil provides mechanical anchorage to plants and holds water and mineral ions for the plants. They provide a basis for the activities of micro-organisms and animals. Soil contains organic and inorganic colloids, electrolytes, organic matter and soil organism. Soil water forms the lifeline of soil organisms, since proper growth of micro-organisms and invertebrate population within the soil occurs in soil containing adequate moisture. Water is a solvent for the organic nutrients as well as minerals and thus, its contents regulate the physiological, morphological and anatomical features of plants.

Air, found in soil pores, contains CO_2, O_2, and N_2 while their quantity differs from soil to soil. Soil air is a very important edaphic factor that determines the types of micro-organisms, soil animals and vegetation that can grow in the soil. Similar to soil water, it also brings about morphological, physiological and anatomical changes in plants and animals. The temperature of the soil is very important as it affects the growth of microorganisms, plants and animals. The temperature influences growth of the roots, the ability of the roots to absorb nutrients and movement of organisms.

Soil pH and salinity are also important because when the pH of the soil is very high (highly alkaline) grows on the soil no vegetation. Soil organisms like bacteria, fungi, algae and animals like protozoa, nematodes, earthworms modify the structure of the soil, increase soil fertility, and help to form humus. Nitrogen fixing bacteria and blue-green algae fix atmospheric nitrogen and increase soil fertility. Thus, a change in any of the soil constituents will have a tremendous effect on the whole.

Biotic factors

The living components (animals and plants) of the environment are considered as biotic factors. Organisms in the environment interact among themselves and this may be intra-specific (between populations of same organism) or inter-specific (between populations of different species). Some of the interactions are mutually beneficial while some are beneficial to only one species without harming the others or by harming the others. These interactions are very essential for the occurrence of the biotic factors.

Based on the nature of the influence, these interactions can be classified as follows:

(i) Symbiosis

In symbiosis, two different species depend upon each other metabolically and thus, are mutually benefitted. The species are known as *symbionts*. For example, *Rhizobium bacteria* and *leguminous roots* are the symbionts. In this case, the bacteria get protective space to live in and derive readymade food from leguminous roots. The leguminous roots, on the other hand, utilize the fixed nitrogen in the bacteria to manufacture proteins.

(ii) Commensalism

In this case, one species is benefited while the other either benefits or remains neutral. The members are called the *commensals* and this association, is known as *commensalism*. For example, some *algae* and *fungi* join together to form a different life form known as *lichens*. The *algae* manufacture food through photosynthesis, which the *fungi* utilize and in return, the *fungi* protects the *algae* from drying up and together both colonize tree barks, rocks, etc. Some terrestrial insects and marine animals share the nest or burrow of others without causing any damage to it.

(iii) Parasitism

In this case, there are two different species, i.e., one is the *parasite* and the other, *host*. In this relationship, it is the parasite that is benefited and the host harmed. The two different species may be two plants or animals; for example, mosquitoes, bedbugs, lice are the parasites which live on hosts like animal and man, harming them.

(iv) Epiphytism

In this case, *epiphytes* grow on other plants, but do not derive food from them; for example, *Lianas*, a woody plant has roots in the ground but takes the support of other plants to climb.

Some carnivorous plants, like Nepenthes, a pitcher plant, grows on other plants but derives food from insects. They have folded leaf lamina, modified into a

pitcher-like structure with a lid. Zooplankton enters into the structure through the lid, gets trapped and the soft parts of its body gets digested by the Nepenthes.

(v) Competition

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Organisms survive on some materials and if these are found inadequate, competition occurs. This competition may be both intra-specific and inter-specific. This leads to the survival or dominance of certain species over others. As all species cannot tolerate same range of temperature, humidity, etc., only those who can, survive.

Limiting factors

Limiting factors denote the amount of substance that is either *least abundant* or *overabundant* in relation to the need of the living organism. Limiting factors may be density dependent, for example, when the food stock is fixed for a given density of population, overpopulation will lead to scarcity of food. Limiting factor may be density independent, for example, earthquake or tsunami may wipe out an entire population irrespective of whether there are few or many. The density independent limiting factors affecting living organisms may be abiotic factors like climate, soil, wind, temperature, water, etc., or other biotic factors. Some climatic conditions may not be tolerable to certain species and might reduce their population, or in extreme cases, make them extinct. If the soil does not have proper amount of nutrients, air and moisture, the plants will not prepare balanced and sufficient amount of food to support animal life, reducing their population. Biotic factors are the most important limiting factors that influence the growth and distribution of plants and animals.

Laws of limiting factors

To explain the effect of different limiting factors on living organisms, number of laws and principles have been proposed by different scientists. They are as follows:

1. ***Liebig's Law of Minimum:*** An organism requires minimum quantity of a particular nutrient for its proper growth and if it is depicted below the critical minimum level, the organism will fail to grow or will grow abnormally; for example, if the soil is deficient in any one nutrient, it will make the other nutrient metabolically inactive and the proper growth of the plant will get restricted.
2. ***Blackman's Law of Limiting Factor:*** A biological process is controlled by a number of factors and the deficiency of any of these factors will affect the process on the whole; for example, photosynthesis by plants. Photosynthesis is dependent on the correct amount of water, carbon dioxide, chlorophyll, intensity of solar radiation and temperature of chloroplast. A deficiency of any of these factors will affect the rate of photosynthesis.
3. ***Shelford's Law of Tolerance:*** The law states that, it is not only that the minimum amount of a material can be a limiting factor, but also the excess

amount of the same material can be limiting to the growth and development of an organism; for example, all the soil nutrients are equally important for the growth and development of plants, but anything in excess might limit the uptake of the other nutrient, restricting the proper growth. Every organism, thus, has an ecological minimum and maximum for every factor and the range between two limits is known as limit or zone of tolerance. Thus, every environmental factor has two zones:

(*i*) Zone of tolerance (*ii*) Zone of intolerance

(i) Zone of tolerance: This zone is favourable for the growth and development of all organisms. Zone of tolerance can be sub-divided into the following (see Figure 2.1):

(*a*) *Optimum zone:* It is the most favourable zone for the growth and development of an organism.

(*b*) *Critical minimum zone:* It is the lowest minimum limit below which growth and development of the organism ceases.

(*c*) *Critical maximum zone:* It is the highest maximum limit above which growth and development of the organism ceases.

(ii) Zone of intolerance: Tolerance with respect to various factors differs from species to species. Organisms that have a wide range of tolerance for all factors have a better chance of survival, and hence, are widely distributed.

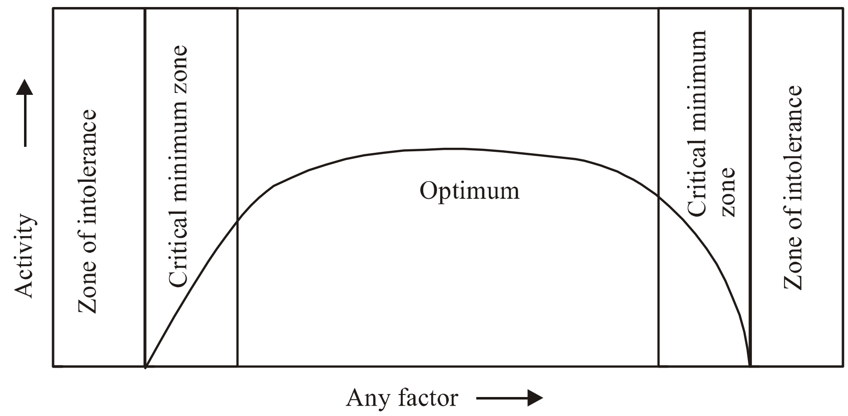


Fig 2.1 *Range of Tolerance*

Ecological instability

When an ecosystem is unable to adjust to the environmental changes, it is said to be unstable. The instability occurs due to a number of natural and anthropogenic activities such as destruction of natural vegetation and animal species, partly or completely or by replacing them by other vegetations and animals, introduction of toxic substances like insecticides and pesticides and toxic gases like SO_2, NO_2, etc.

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2.2.1 Environment and Culture

Culture is significant for many things, for instance climate. Each nation has its own way of life. Culture is more than just about language, conventional garments, nourishments, or perhaps dance. Culture assumes a main part in forming a nation's climate. For instance, everywhere in the world plastic packs are used for packing many things like food, garments, etc. Plastic bags are not favourable for our current world situation in which the environment is facing a high level of pollution and degradation as plastic does not disintegrate. Thus many countries have put a ban on single-use plastic and have advertised for using paper bags and other alternatives. In such countries, forbidding the use of plastic has become a basic way of life. This shows that how culture shapes people's mentalities towards the climate.

Climate place in contemporary talk of culture can be analyzed from two wide viewpoints: one is more extensive civilizational buildings of humanity and the other is regular social life in a given society. Endeavours to associate a country's social accomplishment to a specific climate have been made for quite a while. For example, an Arab researcher in the medieval times noticed that the individuals of northern Europe had been so influenced by the outrageous separation from the sun that they started to develop fair skin tone and 'mental visual impairment'. During the time of European strength around the world, climate turned into a significant topic of discussion and force. In the eighteenth century Europe, a desire for creating racial classification in accordance with the ecological variables prompted the development of the hypothesis of 'climatic determinism'. This hypothesis was promoted by the compositions of a French scholarly, Montesquieu, who stated that individuals in hot atmosphere would feel both physical and mental issues more enthusiastically than the occupants in the cold areas. He contended that the individuals in the previous locales were anxious and wild, thus a solid tyrannical guideline was more fitting for them, though the individuals in the chilly districts were inconsistently fit to a more equitable request. Climatic determinism was before long supplanted by 'organic determinism' whose advocates, for the most part known as Social Darwinists, contended that Europeans of the nineteenth century had a predominant function over the Non-European world since they were organically prevalent, showing a reverberation of the confidence in 'natural selection' in the regular world. In the 20th century, especially in the post-WWII period, the scholarly act of partner race with climate lost ground and a more unique understanding of nature surfaced. On account of close cooperation between individuals' regular social life and their indigenous habitat, Ibn Khaldun was perhaps the most punctual researcher who, while inspecting the social existence of the Arab Bedouins, looked to discover linkages between a specific way of life and the actual climate in which it prospered. In contempory times an auxiliary of Social Darwinism advanced the theory that humans are different from other living creatures in the world and their conduct should be represented by natural drives and senses.

Subsequently, fighting and viciousness were compared to 'forceful sense', mass conduct to the 'grouping nature' and homemaking to the 'settling intuition'.

In the mid-20th century, the natural talk of culture was gradually supplanted by mental clarifications. Behaviourists argued heredity or 'intuition' as results of social acts of person, and contended that the behaviours of individuals was directed by the events in their actual climate. While nature's impact on both civilizational and past social examples has been valued, the weakness of nature itself has not been analyzed enough in its connection with culture; nature simply represented the changelessness that should be penetrable through existence. It is without a doubt, as of late that the social ecological discussion has been educated more by a sense regarding weakness of nature than by its apparent supremacy. Along these lines, a staggering feeling of weakness of humankind in the wake of natural corruption has added to the rise of differed, pluralist and infinitesimal investigation of connection among climate and culture

Influence of Culture and Environment on an Individual's Life

Various authors have given different meanings of culture, with the hint of culture as a lifestyle of people. E.B. Taylor, an eighteenth-century anthropologist who instituted the term, characterized culture as "that perplexing entirety which incorporates information, convictions, workmanship, ethics, laws, custom and some other abilities and propensities as needed by man as a citizen" (White, 1959). The term climate alludes to the environmental factors where we live. Culture and climate cooperate in the respect that culture changes all around. Different gatherings of individuals with various societies can likewise occupy a similar climate or topographical area. Social and ecological factors straightforwardly influence a person's life, for example, well-being, information, and sociological and monetary pursuits.

Culture and climate influence well-being, which is fundamental to one's life. These impacts decide factors, for example, admittance to quality medical care just as specific highlights of the climate, lodging, clean water supply, and clean air. Social qualities like emphasis on sound living, through measures, for example, the arrangement of good medical care and clean water, guarantee people remain healthy. An absence of these qualities would conceivably cause disintegration of well-being in the populace because of breakout and spread of infections and diseases. Healthy people are progressively beneficial. Along these lines, well-being which is influenced by climate and culture, plays a significant role in an individual's life.

One's information is additionally dependent upon social and ecological influences. Information includes viewpoints such as thoughts, values, convictions, abilities, and ethics which are integral to any culture. Similarly, explicit information exists in the natural angle, where an individual's current circumstances are seen as far as geological area. For instance, higher aptitude would be pervasive in the people living in a mountainous region rather than the ones living near water bodies,

for example, lakes and seas. Thus, culture is fundamental in the dispersal of information, where a thought or an idea of a person impacts others and a person's information is liable to be impacted by culture and climate.

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The connection between culture and climate impacts sociological perspectives, for example, decision of living space and monetary pursuits. This is basic among little and "crude" social orders where such decisions rely upon the climate. For instance, Eskimos in the Arctic area live in snow houses because of their cold climate and thus setting up their culture accordingly. Nomads are more inclined to endeavours of acquiring food supply in the area they live for a particular period of time. In this way, setting up societies and the culture in accordance with the climate impact these people.

The interactive nature of culture and environment influences various aspects of humans such as health, education, and means of living like habitat and economic activity. These factors directly affect one's quality of life and outlook towards life. Health is a major determinant of an individual's efficiency in goal-oriented activity, while knowledge puts one in a favourable position to pursue certain interests, as well as find solutions to challenges. Social choices such as habitat and economic activities also affect an individual's life experience. Culture and environment are therefore important factors which influence aspects that affect one's life.

Impact of Environmental Change on Human Well-being

Human prosperity is subject to products and ventures resulted from well-working biological systems. Changes in biological system status and trustworthiness can subsequently affect the human prosperity. In any case, neither the effect of current biological system nor the strategies to strengthen environment administrations consolidate techniques to evaluate the effects of changes in environment on the well-being and prosperity of humans. Changes in these parts of social relations can have a stream of effects on social capital, informal organizations, levels of trust and physical and emotional well-being. Changes in environment condition may likewise have more straightforward effects on human wellbeing through bacterial pollution of recreational waters, the presence of poisons in fish, or through the presence of harmful algal blossoming in recreational waters. A State's revenue is influenced by the changes in water bodies' environment, which may be due to fishing, hydroponics and the travel industry businesses.

Humans affect the vast majority of the world's biological systems today and are liable for overseeing a large portion of the world's resources. Regardless of our expanding attention to the negative effects that a large number of our exercises have on these environments, as a tradition we have been proceeding with utilizing regular resources at a quicker rate than they are replenished. One reason for this is that people in general oversee frameworks on the basis of benefit they could get from them. This advantage has customarily been estimated in terms of monetary value.

Check Your Progress

1. What are eco-factors?
2. What is climatic determinism?

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2.3 CONSERVATION

Air, minerals, soil, trees, water and wildlife are earth's natural resources. Conservation is about taking care of these natural resources so that they can be available in their pristine condition for the future generation. Nature conservation includes maintaining diversity of species, genes, and ecosystems along with the functions of the environment, such as nutrient cycling. It focuses on the sustainable use of nature and its resources by humans. In this section we will study about various methods to conserve nature. This will begin with individual measures and will be followed by global conventions that have been entered upon.

2.3.1 Individual Measures

Different natural resources like forests, water, soil, food, mineral and energy resources play a vital role in the development of a nation. With our small individual efforts we can help in conserving our natural resources to a large extent. The following are some of the ways:

Conservation of water

1. Do not keep water taps running while brushing, shaving, washing or bathing.
2. Fill water in washing machines only upto the level required.
3. Install water-saving toilets that use not more than six litres per flush.
4. Check for water leaks in pipes and toilets and repair them promptly.
5. Reuse the soapy water of washing from clothes for gardening, driveways, etc.
6. Water the plants and the lawns in the evening when evaporation losses are minimum. Never water the plants in mid-day.
7. Install a system to capture rain water.

Conservation of energy

1. Turn off lights, fans and other appliances, when not in use.
2. Obtain as much heat as possible from natural sources. Dry the clothes in sun instead of using dryers.
3. Use solar cooker for cooking, which will make the food more nutritious and will save your LPG expenses.

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4. Build your house with provision for sunspace, which will keep your house warmer and will provide more light.
5. Drive less, make fewer trips and use public transportations whenever possible. Share a carpool if possible.
6. Control the use of air conditioners.
7. Recycle and reuse glass, metals and paper.
8. Use bicycle or just walk down small distances instead of using an automobile.

Protection of soil

1. Grow different types of ornamental plants, herbs and trees in your garden.
2. Grow grass in the open areas that will bind the soil and prevent its erosion.
3. Make compost from your kitchen waste and use it for your kitchen-garden.
4. Do not irrigate the plants using a strong flow of water as it would wash off the soil.
5. Better use sprinkling irrigation.

Promotion of sustainable agriculture

1. Do not waste food; take as much as you can eat.
2. Reduce the use of pesticides.
3. Fertilize your crops with organic fertilizers.
4. Use drip irrigation.
5. Eat local and seasonal vegetables.
6. Control pests.

2.3.2 Reduce, Reuse and Recycle

The role of each individual human is important for collective action to save the planet and its resources before it is too late. Each individual needs to adopt sustainable ways and propagate the same around him or her. The principle or 'reduce, reuse, recycle' needs to be followed, for which people need to change their attitudes, that is, discard the 'use and throw' mentality and adopt an eco-friendly lifestyle. Some of the steps that an individual can take are as follows:

Reduce

Buy less: Before buying a product, one must think if it is really necessary, in other words, 'think before you buy'. This is because the production of each item has an impact on the environment in terms of resources used in making it. Also, when it is discarded, it adds to the waste, and its disposal has an impact on the environment. Many items, especially electronics, batteries, etc., have toxic chemicals, which are hazardous.

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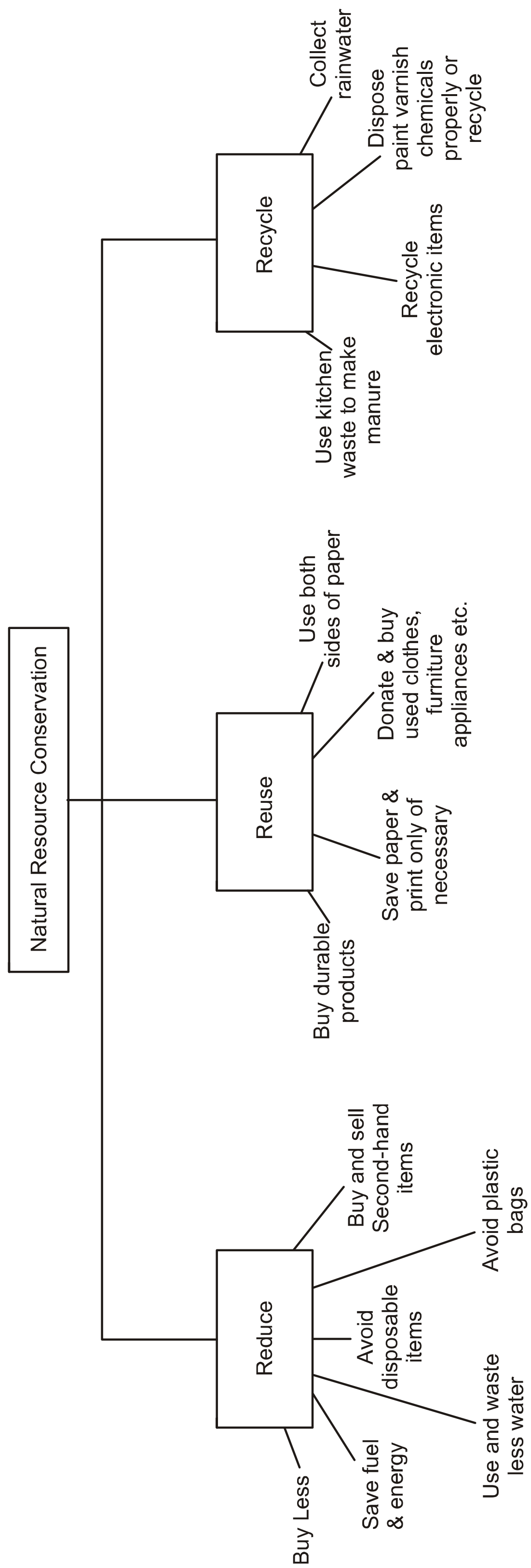


Fig 2.2 *Conservation of Resources*

Say no to disposable items: As much as possible, avoid disposable items like Styrofoam plates and cups, use-and throw pens and razors, paper napkins. Instead use reusable products. It also better to use rechargeable batteries, which can be used again and again. They not only reduce the harm to the environment, they also save money in the long run.

Buy and sell used products: Buying and selling second-hand items like books, furniture, electronics saves the earth's resources and the consumer's money. These can be bought from local sellers or through the Internet.

Minimize waste: This can be done by buying only as much as necessary, avoiding products with excessive packaging, avoiding products that are packaged for single use and buying in bulk.

Say no to plastic bags: Carry your own reusable shopping bag when going to the market. Plastic shopping bags are a major source of trash around the world. It is estimated that about 500 billion-1 trillion plastic bags are used worldwide every year, out of which less than 1 per cent is recycled. Plastic bags end up in trash dumps and in water bodies like rivers, lakes and oceans. They choke drains and because of their toxic composition, they poison the water and soil. They also kill animals who swallow them, mistaking them for food. A large number of marine animals like whales, dolphins, turtles and seals die due to plastic bags.

Reduce energy use at home and workplace: Turn off lights, air conditioners, fans and appliances when not in use. Use energy-saving CFL (compact fluorescent lamps) instead of regular incandescent bulbs, which waste a lot of energy. Check for the energy-star ratings before buying electronics. Use natural light during the day instead of electric lamps. Wear extra warm clothing during winter rather than turn up the heating. In summer, open the windows to let in the breeze instead of using the air conditioner. Use solar cookers.

Save fuel: Avoid the use of car for travelling short distances. Use public transport as much as possible. Form carpools for going to work, school or college. Walk or cycle short distances.

Reduce the use and wastage of water: Avoid long showers; use bucket for bathing. Do not let taps run while brushing, shaving, bathing or washing. Use low-flush toilets and check for water leaks in pipes and toilets and repair them promptly.

Reuse

Many of the products we discard and throw away can be reused directly or indirectly in some other way. For example, plastic containers can be used for storing food items, bottles can be used to store water, while old clothes can be given away to charity or used to make shopping bags or mops, etc. Instead of throwing away electronic items, they can be repaired and reused. Alternatively, they can be given away to someone who needs it.

Here are several ways to reuse:

- Donate (and buy used) household items like clothes, furniture, dishes, appliances and electronic items.
- Buy and sell used books and magazines, or donate to libraries.
- There are NGOs, food banks and soup kitchens that collect food items that are left over from parties and events.
- Buy long-lasting and durable products.
- Save paper by printing only when necessary. Use both sides of paper — for writing or printing documents from your computer. Blank pages from used notebooks can be used for making new notebooks. Used paper can be stapled together to make note-pads.

Recycle

- Kitchen waste such as fruit and vegetable peels and garden waste like leaves can be composted in a pit or bin to make manure.
- Recycle electronics such as mobiles. Many companies have takeback schemes or drop-off facilities, where old mobile phones can be given away for recycling.
- The following products/materials can be recycled:
  - o glass
  - o paper products
  - o Plastic containers
  - o aluminium
  - o cardboard
  - o tin cans
  - o scrap metal
  - o ink cartridges
  - o household appliances such as refrigerators
  - o computer equipment and other electronic devices
  - o styrofoam
  - o tyres
- Hazardous products such as the following need to be recycled or disposed of properly:
  - o Paint, varnish, paint thinner, etc.
  - o Automotive products like engine oil, brake fluid, kerosene, used motor oil, used oil filters, used antifreeze, etc.

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- o Chemicals products used in the house such as stain removers, bathroom cleaners, mosquito repellents and insect sprays, CFLs (contain mercury), batteries, acids, etc.
- o Garden products like insect killers, weed killers, fertilizers and pesticides

- Reuse water: Collect rainwater and use it for watering plants or washing car. Soapy water from the washing machine can be used for mopping floors and washing cars.

2.3.3 Global Conventions for Environmental Conservation

In the 1970s, it was realized that there were 'limits to growth'. If growth continued unbridled at the existing rates, it was asserted that it would exhaust the limited stock of natural resources of the earth. Although technological innovations have contributed in pushing outwards the 'limits to growth', it is now being argued that the limits must be evaluated in terms of the 'carrying capacity' of the environment. There is a consensus over the fact that growth without commensurate efforts at environmental protection will pose a global threat. The international community has responded to this perceived threat and environmental protection and sustainable development concerns are now on a high priority of the international agenda.

The last century has seen a proliferation of international legal instruments—declarations and agreements—aimed at environmental protection. Whereas declarations are more general in nature, containing a general commitment to the environmental protection without being legally binding, agreements contain binding obligations for the member states and deal with specific issues relating to particular environmental problems.

On various occasions, the highest representatives of states and governments have got together at international conferences on environmental protection and development. The basic principles for environmental protection, such as the precautionary principle, the polluter pays principle and the principle of sustainable development, etc., have also taken shape. Moreover, an international structure has been put in place, which is devoted to furthering the objective of environmental protection. There is also talk of setting up a centralized world body—a World Environment Organization (WEO)—to address the problems of environment. However, despite the intensified efforts at the international level, there are numerous challenges that must be met in order to allow these initiatives to be successful in their endeavour.

Various environmental problems have been identified, some related to the conservation of natural resources and ecosystems, such as forests, wildlife, biodiversity, wetlands, migratory species, etc. These issues put a question mark on how much the earth can give. Other issues relate to ensuring that we stay within the limits of the 'carrying capacity' of the environment. These issues, mostly relating to ozone depletion, global warming, hazardous wastes, persistent organic pollutants

(POPs), hazardous chemicals, genetically modified organisms (GMOs), atmospheric pollution, marine pollution, etc., relate to the basic question of how much the earth can take. Because of the diversity of environmental problems, the legal regime at the international level is necessarily fragmented, with over 200 Multilateral Environmental Agreements (MEAs) each dealing with different environmental problems.

The basic principles of environment management are increasingly being incorporated into the political constitutions since the Stockholm Conference on Human Environment held in 1972. The Stockholm Conference has taken issues such as proper use of natural reserves, environmental development as well as ecological pollution into consideration and they have found expression in the constitutional form. These are often articulated in terms of obligations which are stated clearly to its citizens. Moreover, a duty is often imposed on citizens to safeguard the national environment. Most of the developing countries exhibit this constitutional trend.

National and International Legislations

A survey of national environmental legislation reveals an important range of judicial mechanism for environmental management. These include anti-pollution laws, the codification of environmental and natural resources laws, and framework of legislations.

Like national legislations, there is no international legislative body with the authority to pass legislations, nor are there international agencies with the power to regulate resources on a global scale. The International Court at Hague in the Netherlands has no power to enforce its decisions. Powerful nations can simply ignore the Court. As a result, international legislation must depend on the agreement of the parties concerned.

Certain issues of multinational concern are addressed by a collection of policies, agreement and treaties that are loosely called International Environmental Legislations. Most of the international legislations are international agreements to which nations adhere voluntarily. These agreements are generally finalized through international conventions or treaties. Nations that have agreed to be bound by the conventions are known as Parties. Convention provides a framework to be respected by each party, which has to adopt its own national legislations to make sure that the convention is implemented at the national level. Protocols are framed to support conventions. It is an international agreement that stands on its own that is however linked with an existing convention. For example, the climate protocol shares the concerns and doctrines that are set out at the climate convention. Followed by this, the protocol builds on these by adding new commitments that are stronger, more complicated, and comparatively more detailed than those existing in the convention. The United Nations has a significant role to play in developing as well as implementing conventions.

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Major international environmental legislations exist in the following five areas:

- Pollution of international watercourses
- Marine pollution
- Atmospheric pollution
- International transfers of hazardous waste
- Risks of nuclear energy

Key International Environmental Treaties

International watercourses

- 1992 Helsinki Convention on the Protection and Use of Transboundary Water-courses and International Lakes

Marine pollution

- 1973 Convention for the Prevention of Pollution from Ships (MARPOL)
- 1982 UN Convention on the Law of the Sea (UNCLOS)
- 1992 Paris Convention for the Protection of the Marine Environment of the North-East Atlantic
- 1958 Geneva Conventions on the Territorial Sea and Contiguous Zone, the High Seas, Fishing and Conservation of the Living Resources of the High Seas, and the Continental Shelf

Atmospheric pollution

- 1979 ECE Convention on Long-Range Transboundary Air Pollution protocols on sulphur dioxide (SO2), nitrogen oxides (NOx), and volatile organic compounds (VOCs)
- 1985 Vienna Convention for the Protection of the Ozone Layer (Montreal Protocol and London and Copenhagen Amendments)
- 1992 UN Convention on Climate Change
- Kyoto Protocol

Hazardous waste

- 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
- 1991 Bamako Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa

Nuclear energy

- 1986 IAEA Convention on Early Notification of a Nuclear Accident
- 1986 IAEA Convention on Assistance in the Case of a Nuclear Accident
- 1994 IAEA Convention on Nuclear Safety

Others

- 1991 ECE Convention on Environmental Impact Assessment in a Transboundary Context
- 1992 UN Convention on Biological Diversity

Some Global Environmental Initiatives

One of the favourable initiatives that reversed the catastrophic impact of modern development on ecology relates to the ozone layer. Depletion of the ozone layer was confirmed way back in the late 1970s. The depletion resulted in an increased ultraviolet radiation that causes deadly diseases such as skin cancer. Global action regarding the same was taken much later in 1985, when the United Nations organized a convention on the Protection of the Ozone Layer in Vienna in 1985. In a short while, following the convention, satellite images captured ozone holes over the Antarctic that grabbed immense public attention. This issue prompted the Montreal Protocol of 1987 that resulted as an outgrowth of the Vienna Convention. The major objective of the Montreal Protocol was to impose obligations on the developed countries to reduce the use of ozone depleting substances.

Much later when the causal effects of the CFCs were proved, the 1990 London Protocol was organized which took effect and agreed upon to reduce the CFC levels largely by 85 per cent by 1997. According to the London Protocol, countries with developing economies agreed to take on accountability with a grace period. The developed countries underwrote a trust fund of US $ 240 million to assist them.

The resultant effect was a considerable reduction in the atmospheric concentrations of ozone-depletion followed by an eventual improvement of the same. The issue of the ozone layer was much easier to handle than other issues such as climate change and biodiversity erosion. The political scenario around the world also started taking the problem of ozone depletion seriously.

At the national level, the wealthy industrial nations responsible for most of the production, were also those at the greatest risk from skin cancer. Further, the production and use of ozone-depleting substances was not central to any economy—unlike greenhouse gases, whose production is deeply embedded in the energy and transport sectors.

In spite of a number of hurdles, the United Nations has been at the forefront in taking initiatives to mitigate the global environmental problems, which are likely

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to exacerbate if the present trend of economic globalization continues unabated. A major UN initiative came after the UN Conference on the Human Environment (UNCHE) in 1972 at Stockholm. As you know, the United Nations Environmental Programme (UNEP) was created in 1972 'to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations'.

The UNEP initiative, however, remained dormant for almost two decades until early 1990s. There was growing concern about global warming. Under global pressure, the UN Convention on Climate Change was adopted in 1992. In 1997, the Kyoto Protocol was signed which called for industrial countries to reduce emissions by 5.2 per cent, compared to 1990 levels, by 2008–2012. But the US, which is responsible for one-fourth of the world's total carbon emission, refused to ratify the Kyoto Protocol on the ground that the developing countries were exempted. The developing countries, on the other hand, demanded that the 'polluting' North pay costs and transfer resources to compensate for the losses suffered by them. The carbon convention is a positive step in this direction.

The UN Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 is seen as a landmark in evolving a blueprint for the 21st Century. The Commission for Sustainable Development (CSD) was established in 1992. Though, Global Environmental Facility (GEF) was established in 1991, it was restructured in 1994, in the light of developments and conventions since the Rio Conference. Recognizing the importance of biodiversity for the survival of life, including human life on the earth, and sharing concern over the loss of biodiversity by unprecedented levels since 1980s, the Convention on Biological Diversity (CBD) was convened in 1992, and among other things, it reaffirmed sovereign rights of the states over their natural resources and agreed to establish a fund through GEF to pay for the use of genetic resources of developing countries.

Unlike the initiative on ozone layer, the progress on other major environmental issues like climate change and biodiversity is very tardy. It appears that while economic globalization seems to be increasingly embedded in strong institutional support systems, 'ecological globalization' seen in terms of challenges to sustainable development is still in search of empowered institutional support. At least two shortcomings are discernible. First, the process of global environmental threat is not accompanied by any strong political support. As a result, no political leader has any interest to ensure that the emerging global ecological policy is managed in the best interest of the maximum number of people and on the basis of the principles of 'good governance', that is, equality, justice and democracy.

Second, there is no clear and transparent mechanism to integrate the two processes of economic and ecological globalization. But nations are doing so individually, often in a covert manner, through the positions they take to set the rules for the two processes of globalization. When the leaders of nation states

meet to develop rules and regulations for economic globalization, they take positions to derive the maximum economic benefits for their national economies. When they meet to develop the rules and regulations for ecological globalization, they take positions which ensure that there would be either no costs or, at worst, least possible costs to their individual national economies.

As a result of these two shortcomings, the rules and regulations that are emerging generally tend to be based on the principles of business transactions rather than on the principles of 'good governance'. Environmental diplomacy has turned into petty business transactions, and not the establishment of fair and just global environmental governance systems. While business transactions are built on the principles of mutual benefits regardless of their societal costs, governance systems are built on the principles of democracy, justice and equality.

For international environmental negotiations that deal with pollution or degradation, global equity is of utmost importance. The issue of equity has become a very contentious one in environmental diplomacy. Equity is a prerequisite for global agreement, and environmental cooperation can only be possible through solutions that are both equitable and 'ecologically effective'. Without equity or a sense of fair play it is quite unlikely that there will be a long lasting partnership to address and solve global problems. Global equity is particularly important in global environmental negotiations which deal with the pollution or degradation of global common property, such as the stratospheric ozone layer, the atmosphere or the oceans. So far, these common property resources are seen as free access resources—a situation that aided the industrialization process of early entrants.

2.4 GREEN HOUSE EFFECT

The phenomenon that worries the environmental scientists is that due to anthropogenic activities, there is an increase in the concentration of the greenhouse gases in the air that absorbs infra-red light containing heat and results in the re-radiation of much of the outgoing thermal infra-red energy, thereby increasing the average surface temperature beyond 15°C. The phenomenon is referred to as the enhanced greenhouse effect to distinguish its effect from the one that has been operating naturally for millennia. The greenhouse gases include carbon dioxide, chlorofluorocarbons, methane and nitrous oxide. These are the greenhouse gases present in the troposphere which result in an increase in the temperature of air and earth.

Impacts of Enhanced Greenhouse Effect

The enhanced greenhouse effect will not only cause global warming, but will also affect various other climatic and natural processes.

1. **Global temperature increase**: It is estimated that the earth's mean temperature will rise between 1.5 to 5.5 °C by 2050, if inputs of greenhouse

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gases continues to rise at the present rate. Even at the lower value, earth would be warmer than it has been for the past 10,000 years.

2. **Rise in sea level**: With the increase in global temperature, sea water will expand. Heating will melt the polar ice sheets and glaciers, resulting in further rise in the sea level. Current models indicate that an increase in the average atmospheric temperature of 3°C would raise the average global sea level by 0.2-1.5 metres over the next 50-100 years. One metre rise in sea level will inundate low-lying areas of cities like Shanghai, Cairo, Bangkok, Sydney, Hamburg and Venice, as well as agricultural lowlands and deltas in Egypt, Bangladesh, India and China. This will affect rice productivity. This will also disturb many commercially important spawning grounds, and would probably increase the frequency of storm damage to lagoons, estuaries and coral reefs.

   In India, the Lakshadweep Islands with a maximum height of 4 metres above the sea level is vulnerable. Some of the cities like Mumbai may be saved by heavy investment on embankments to prevent inundation. Life of millions of people who have built homes in the deltas of Ganges, the Nile, the Mekong, the Yangtze and the Mississippi rivers will be affected, by the sea level rise.

3. **Effects on human health:** The global warming will lead to changes in the rainfall pattern in many areas, thereby affecting the distribution of vector-borne diseases like malaria, filariasis and elephantiasis. Areas which are presently free from diseases like malaria may become the breeding ground for the vectors of such diseases. The areas likely to be affected in this manner are Ethiopia, Kenya and Indonesia. Warmer temperature and more water stagnation will favour breeding of mosquitoes, snails and some insects, which are the vectors of such diseases.

   Higher temperature and humidity will increase/aggravate respiratory and skin diseases.

4. **Effects on agriculture:** There are different views regarding the effect of global warming on agriculture. It may show positive or negative effects on various types of crops in different regions of the world. Tropical and subtropical regions will be more affected since the average temperature in these regions is already on the higher side. Even a rise of 2°C may be quite harmful to crops. Soil moisture will decrease and evapo-transpiration will increase, which may drastically affect wheat and maize production. Increase in temperature and humidity will increase pest growth like the growth of vectors for various diseases. Pests will adapt to such changes better than the crops. To cope up with the changing situation, drought resistant, heat resistant and pest resistant varieties of crops have to be developed.

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Check Your Progress

3. What do you mean by conservation?
4. Name some renewable resources of energy.
5. What is the difference between declarations and agreements?
6. What change was brought over by the Stockholm Conference for environmental protection?
7. Name the areas that are covered by the major international environmental legislations.
8. What was the purpose behind the creation of the United Nations Environmental Programme?
9. What is enhanced greenhouse effect?

2.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. In an ecosystem, a living organism is influenced by a large number of environmental factors. These environmental factors are known as ecological factors or eco-factors.
2. Climatic determinism is a system of creating racial classification in accordance with the ecological variables. This hypothesis was promoted by the compositions of a French scholarly, Montesquieu.
3. Air, minerals, soil, trees, water and wildlife are earth's natural resources. Conservation is about taking care of these natural resources so that they can be available in their pristine condition for the future generation.
4. There are some renewable resources, e.g., solar power, wind power and geothermal power.
5. Declarations are more general in nature, containing a general commitment to the environmental protection without being legally binding. Agreements on the other hand, contain binding obligations for the member states and deal with specific issues relating to particular environmental problems.
6. Since the Stock Conference in 1972, the basic principles of environmental protection are increasingly integrated into the political constitutions.
7. The areas covered by major international environmental legislations include pollution of international water courses, marine pollution, atmospheric pollution, international transfer of hazardous waste and the power of nuclear energy.

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8. The United Nations Environmental Programme (UNEP) was created in 1972 ‘to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations’.
9. An increase in the concentration of the greenhouse gases in the air that absorbs infra-red light containing heat and results in the re-radiation of much of the outgoing thermal infra-red energy, thereby increasing the average surface temperature beyond 15°C. The phenomenon is referred to as the enhanced greenhouse effect.

2.6 SUMMARY

- Ecological balance or stability of the ecosystem implies a balance between the production and consumption of each component in the ecosystem.
- If there is diversity of food webs, it will lead to an increase in number of links in the food web and if community succession operates in an ecosystem, the stability will increase.
- The differences in vegetation of a desert and a rain forest, fish in sweet water and saline water, animals in tropical countries and cold countries, clearly indicate the role of environmental factors in the distribution and survival of organisms in different eco-systems.
- Light plays a vital role for both plants and animals. Sunlight is the ultimate source of energy for the biological world. Light is highly essential for photosynthesis, plays an important role in respiration and transpiration, regulates hormones in plants thereby modifying the shape and size and influences the growth and development of flowers, fruits, germination and distribution of plants.
- The physical geographical factors are known as *topographic factors*. These factors include altitude, slope and direction of mountain chains and valleys. All these factors affect the climatic conditions of a place and thereby influence the distribution of organisms.
- Edaphic factors deal with the structure formation and characteristics of different types of soils.
- Air, found in soil pores, contains CO_2, O_2, and N_2 while their quantity differs from soil to soil. Soil air is a very important edaphic factor that determines the types of micro-organisms, soil animals and vegetation that can grow in the soil.
- The living components (animals and plants) of the environment are considered as biotic factors. Organisms in the environment interact among themselves and this may be intra-specific (between populations of same organism) or inter-specific (between populations of different species).

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- Limiting factors denote the amount of substance that is either *least abundant* or *overabundant* in relation to the need of the living organism.
- To explain the effect of different limiting factors on living organisms, number of laws and principles have been proposed by different scientists – Liebig's Law of Minimum, Blackman's Law of Limiting Factor and Shelford's Law of Tolerance.
- Culture is significant for many things, for instance climate. Each nation has its own way of life. Culture is more than just about language, conventional garments, nourishments, or perhaps dance.
- During the time of European strength around the world, climate turned into a significant topic of discussion and force. In the eighteenth century Europe, a desire for creating racial classification in accordance with the ecological variables prompted the development of the hypothesis of 'climatic determinism'.
- Air, minerals, soil, trees, water and wildlife are earth's natural resources. Conservation is about taking care of these natural resources so that they can be available in their pristine condition for the future generation. Nature conservation includes maintaining diversity of species, genes, and ecosystems along with the functions of the environment, such as nutrient cycling.
- The principle or 'reduce, reuse, recycle' needs to be followed, for which people need to change their attitudes, that is, discard the 'use and throw' mentality and adopt an eco-friendly lifestyle.
- On various occasions, the highest representatives of states and governments have got together at international conferences on environmental protection and development. The basic principles for environmental protection, such as the precautionary principle, the polluter pays principle and the principle of sustainable development, etc., have also taken shape.
- The basic principles of environment management are increasingly being incorporated into the political constitutions since the Stockholm Conference on Human Environment held in 1972. The Stockholm Conference has taken issues such as proper use of natural reserves, environmental development as well as ecological pollution into consideration and they have found expression in the constitutional form.
- Certain issues of multinational concern are addressed by a collection of policies, agreement and treaties that are loosely called International Environmental Legislations. Most of the international legislations are international agreements to which nations adhere voluntarily.
- One of the favourable initiatives that reversed the catastrophic impact of modern development on ecology relates to the ozone layer. Depletion of the ozone layer was confirmed way back in the late 1970s. The depletion resulted in an increased ultraviolet radiation that causes deadly diseases such as skin cancer.

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- In spite of a number of hurdles, the United Nations has been at the forefront in taking initiatives to mitigate the global environmental problems, which are likely to exacerbate if the present trend of economic globalization continues unabated.
- Unlike the initiative on ozone layer, the progress on other major environmental issues like climate change and biodiversity is very tardy. It appears that while economic globalization seems to be increasingly embedded in strong institutional support systems, 'ecological globalization' seen in terms of challenges to sustainable development is still in search of empowered institutional support.
- The phenomenon that worries the environmental scientists is that due to anthropogenic activities, there is an increase in the concentration of the greenhouse gases in the air that absorbs infra-red light containing heat and results in the re-radiation of much of the outgoing thermal infra-red energy, thereby increasing the average surface temperature beyond 15°C.
- There are different views regarding the effect of global warming on agriculture. It may show positive or negative effects on various types of crops in different regions of the world. Tropical and subtropical regions will be more affected since the average temperature in these regions is already on the higher side.

2.7 KEY WORDS

- **Stability:** It is the state of being stable.
- **Soil pH:** It is a scale used to specify the acidity or basicity of soil.
- **Conservation:** It is the prevention of wasteful use of a resource.
- **Greenhouse gases:** These are the gases that absorb and emit radiant energy within the thermal infrared range, causing the greenhouse effect.

2.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. How does the homeostatic mechanism work in restoring the stability?
2. State the relation between culture and climate of a region.
3. What steps can we take for the protection of soil?
4. What was the 1990 London Protocol?

Long-Answer Questions

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1. Describe the climatic factors that influence the living organism.
2. What are the limiting factors that affect the ecosystems? Explain with the laws of limiting factors.
3. How can the 'reduce, reuse and recycle' strategy be applied in conservation? Explain.
4. Describe the effects of enhanced greenhouse effect.

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UNIT 3 GLOBAL WARMING, OZONE DEPLETION AND BIO DIVERSITY

Structure

3.0 INTRODUCTION

Global warming is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. The term is frequently used interchangeably with the term climate change, though the latter refers to both human- and naturally produced warming and the effects it has on our planet. It is most commonly measured as the average increase in Earth's global surface temperature. Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional and global climates. These changes have a broad range of observed effects that are synonymous with the term. Changes observed in Earth's climate since the early 20th century are primarily driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere, raising Earth's average surface temperature. The ozone layer is a natural layer of gas in the upper atmosphere that protects humans and other living things from harmful ultraviolet (UV) radiation from the sun. Although ozone is present in small concentrations throughout the atmosphere, most (around 90%) exists in the

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stratosphere, a layer 10 to 50 kilometres above the Earth's surface. The ozone layer filters out most of the sun's harmful UV radiation and is therefore crucial to life on Earth. Scientists discovered in the 1970s that the ozone layer was being depleted. Atmospheric concentrations of ozone vary naturally depending on temperature, weather, latitude and altitude, while substances ejected by natural events such as volcanic eruptions can also affect ozone levels. However, these natural phenomena could not explain the levels of depletion observed and scientific evidence revealed that certain man-made chemicals were the cause. These ozone-depleting substances were mostly introduced in the 1970s in a wide range of industrial and consumer applications, mainly refrigerators, air conditioners and fire extinguishers. Ozone layer depletion causes increased UV radiation levels at the Earth's surface, which is damaging to human health. Aquatic life just below the water's surface, the basis of the food chain, is particularly adversely affected by high UV levels. UV rays also affect plant growth, reducing agricultural productivity. Biodiversity is all the different kinds of life one finds in a region, which include a variety of animals, plants, fungi, and even microorganisms like bacteria. Each of these species and organisms work together in ecosystems to maintain equilibrium and support life. Biodiversity supports everything in nature that we need to survive: food, clean water, medicine, and shelter. In this unit, we will study in detail about the global warming, ozone depletion and biodiversity.

3.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the meaning and causes of global warming
- Discuss the factors responsible for and the measures to prevent the climate change
- Explain the impact of climate change in terms of monetary value
- State the importance and the causes behind the depletion of ozone layer
- Describe the levels and principles of biodiversity

3.2 GLOBAL WARMING

Global warming and climate change are perhaps considered to be the greatest threat to the planet. Global warming is threatening the existence of life on this planet. Global warming affects climate in such a manner that it intimately becomes related with our economic, social and political activities. Global warming has affected all the countries of the world. Our planet is one but those who inhabit it have a multicultural perspective. Hence, there are many interests. The pursuit of self-interest leads to exploitation of natural resources. There are many issues within which the environmental issue has to survive. These include issues of intergenerational justice, distributional justice, risks that are voluntary and non-voluntary, altruism

and concern for rationality. The interest of the whole is in conflict with the interest of the individual. An example given by Garrett Hardin, 'tragedy of the commons' explains it comprehensively. Garrett Hardin was an American ecologist who warned of the dangers of overpopulation. In this example, he shows how a common resource will be depleted if more and more people go on using it for their self-interest. It is a fitting metaphor to describe the impact of global warming. Global warming can bring immense changes to the existing natural condition. It brings about change in the natural vegetation, landscape, weather condition and living condition of flora and fauna. The whole of the existing ecosystem is altered due to basic changes brought within it by human activities. Since the ecosystem adjusts to such changes and it may not be favourable every time, the consequences are too many to handle. This kind of warming is caused by humans.

The past acts of the developed countries have contributed to immense global warming resulting in heavy carbon dioxide emissions. The way global warming impacts the atmosphere is highly complex. To grant concessions in terms of carbon dioxide emissions for economic gains has an uneasy feel to it. Climatic changes are rather unpredictable to accommodate any such concessions. The impact can be contained or gradually lightened, but only for the next generation if this generation takes steps in that direction. The more we delay our action, the heavier the burden will be on the next generation. Concepts like geoengineering (using man made ways of bringing large-scale changes in the climate condition), providing with carbon free nuclear energy have their own risks. The misuse of technology is yet another problem. The ethic of means and end relationship which Gandhi has espoused seems to be vital for environmental problems and its solutions. The means-end relationship enjoins that our actions should be ethically as good as the means. In the environmental context, it gains special importance because each act can induce irreparable damage to the environment. The objective of becoming self-sufficient at the basic level is linked with the ethical approval of means in the larger whole. If all our needs are met at the basic place of existence we will not manipulate the environmental resources to our advantage. There is a provision to meet the basic requirement for everyone and one must seek it from the surroundings first. The inner self-restraint is fundamental to such approach.

It is due to previous acts of exploitation of natural resources that we need to look at their harmful effects on us. We need to act in the direction of minimizing the hazards. There are two types of approaches possible towards conservation of nature. Some environmental thinkers feel that restoration has a value in itself. It may not be as real as the original condition of nature, but at least it has some resemblance to the original state. If some past wrong can be slightly corrected then acts of restoration should be permissible. There is a difference between a restoration act done to correct a past wrong inflicted on nature and of another kind which is done just to meddle with nature. This distinction is important because any interference with nature will have an adverse effect on the climate and civilization. In line with this thought some thinkers find interference with nature in the name of

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restoration unjustified. It is simply overestimation of human capacity. With difficulties in bringing things back to normal, not being able to deal with the present impact, we need to re-examine our values. The question of ethics emerges here. Should the developed countries not pay more and limit their emission levels so that poor countries can develop more and have economic prosperity as well? The developed countries argue that the impact of global warming was unknown to them before 1990 so they should not be held entirely responsible for the looming threat as it was committed in ignorance. Though the past acts may not be corrected, all countries need to form a consensus on the actions to be taken for tackling global warming and changes in climate. Concepts of climate justice and ecological debt are frequently raised with little effect on rich and powerful countries. The failure to find a sustainable solution suggests that we are unable to tackle the challenges posed by the current global scenario. The failure to arrive at a common consensus by the political leaders of the world has further emphasized the need to adopt an ethical outlook. Environmental ethics needs to find answers to these problems.

We must consider our past climate changes to study how it led to great geographical changes in the prehistoric era. A fossil pollen analysis reveals how some species moved up towards the north from 200meters to 1500meters per year due to the effect of melting ice. With the increasing effect of global warming the ecosystem might just not survive. Hence, global warming needs urgent attention for the survival of mankind on earth.

Global warming has led to change in the climate, but there are no clear instructions on how to read these changes since all facts have not been discovered. That is why studies in the field of climate change are different. Nonetheless, we cannot delay action till all the facts are not discovered and climate change studies analysed. Human beings have dealt with the natural world according to their own needs and wants without taking into consideration the depletion of natural resources. Scientific study has highlighted the harm caused to the natural environment by humans. It is for us to relate this state with our values to bring changes in it. In the context of climate change economic mediation may not be always successful. The uncertainties are immense and to assess these uncertainties in economic terms is not possible. Approximate ways may lead to further digression. Human beings will also show a corresponding change in their adaptation to the changing climate. Climate change brings variation in all aspects of human life as well as economic life. Everything is dependent on climate change. Forests, fisheries, natural life, wildlife, tourism, agriculture and human living will be changed accordingly. The impact can hardly be accurately evaluated. We can only realize its vast impact on civilization. The management of global climate cannot be successfully attempted through economic evaluation. The only way to deal with this anthropogenic situation is through an adoption of ethical means and value formation. The problem is ethical in nature and must be solved through ethical means. Science and economics are there to facilitate the ethical process. To work towards a better sense of ourselves, the world of nature is the only way to move.

3.2.1 Meaning of Climate Change and Global Warming

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period, for at least thirty years is called climate.

The Intergovernmental Panel on Climate Change (IPCC) in 1990 and 1992 published the best available evidence about past climate changes, the greenhouse effect and recent changes in global temperature. It was observed that earth's temperature has changed considerably during the geological times. It has experienced several glacial and interglacial periods. However, during the past 10,000 years of the current interglacial period, the mean average temperature has fluctuated by 0.51°C over 100 to 200 year period. We have relatively stable climate for thousands of years due to which we have practised agriculture and increased population. Even small changes in the climatic conditions may disturb agriculture that would lead to migration of animals including humans.

Anthropogenic activities are upsetting the delicate balance that has been established between various components of the environment. Greenhouse gases have increased in the atmosphere resulting in the increase in the average global temperature.

This may upset the hydrological cycle, resulting in floods and droughts in different regions of the world, causing sea level to rise, changes in agricultural productivity, famines and death of humans as well as livestock.

Cause of Global Warming

Troposphere, the lower most layer of the atmosphere, traps heat by natural processes due to the presence of certain gases. This effect is called greenhouse effect, as it is similar to the warming effect observed in the horticultural greenhouse made of glass.

The amount of heat trapped in the atmosphere depends mostly upon the concentration of heat trapping or greenhouse gases and the length of time they stay in the atmosphere. The major greenhouse gases are carbon dioxide, ozone, methane, nitrous oxide, and water vapour.

The average global temperature is 15°C. In the absence of greenhouse gases, this temperature would have been 18°C. Therefore, greenhouse effect contributes to a temperature rise to the tune of 33°C.

Heat trapped by greenhouse gases in the atmosphere keeps the planet warm enough to allow us and other species to exist. The two predominant greenhouse gases are water vapour which is controlled by the hydrological cycle and carbon dioxide which is controlled mostly by the global carbon cycle. While the levels of water vapour in the troposphere have relatively remained constant, the levels of carbon dioxide have increased.

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Other gases whose levels have increased due to human activities are methane and nitrous oxide. Deforestation has further resulted in elevated levels of carbon dioxide due to the non-removal of carbon dioxide by plants through photosynthesis.

Warming or cooling by more than 2°C over the past few decades may prove to be disastrous for various ecosystems on the earth, including humans as it would alter the conditions faster than some species could adapt or migrate. Some areas will become inhabitable because of droughts or floods following the rise in the average sea level.

3.2.2 Measures to Control Global Warming

To slow down enhanced global warming the following steps will be important:

1. Cut down the current rate of use of CFCs and fossil fuel.
2. Use energy more efficiently.
3. Shift to renewable energy resources.
4. Increase in nuclear power plants for electricity production.
5. Shift from coal to natural gas.
6. Trap and use methane as a fuel.
7. Adopt sustainable agriculture.
8. Stabilize population growth.
9. Efficiently remove carbon dioxide from smoke stacks.
10. Plant more trees.
11. Remove atmospheric carbon dioxide by utilizing photosynthetic algae.

3.2.3 Climate Change and its Costs

Critical questions have been raised about the role of climate change in the economics of risk, economics of distribution amongst individuals, economics of distribution over time and generations, and economics of different aspects of well-being. Since climate change is a non-marginal, international, inter-generational policy challenge, concerning important questions of risk and ambiguity, our usual shortcuts are unsuitable to find appropriate solutions. Moreover, existing markets do not provide a technocratic solution to the questions of intergenerational justice. Instead, climate change demands that a number of ethical perspectives be considered. Typical welfare economics is one such perspective.

Climate change is a serious challenge faced by the international community striving towards sustainable development. It has implications for not only health and well-being of the earth's ecosystem but also for the economic enterprises and social livelihood. The current models predict a 0.3°C increase per decade in global temperatures over the next century. This is attributed to the increase in the amount of carbon dioxide present in the atmosphere, which has risen by about 25 per cent in the last 150 years. As a global problem, climate change requires a global solution,

which can be made possible by research, shared knowledge and engagement of people at all levels. Within climate change, particular attention needs to be paid to the unique challenges facing the developing countries. The South is likely to be significantly affected by the climate change, yet it typically lacks in the resources needed to adapt to the economic, social and environmental changes expected to occur. Partnership between the North and South countries would give a good understanding of the implications of climate change for these countries and throw light upon how approaches such as the Clean Development Mechanism may be used to meet the sustainable development objectives in the developing countries.

One of the most significant reviews on the economics of climate change is the Stern review. The review maintains that though all countries have to suffer due to climate change, it is the poorest that will suffer the most. However, any positive international action will help slow down this change. Unstopped climatic changes will raise the temperature by at least 5 degrees than the pre-industrial era. This will change the physical as well as human geography of the world. This will prove to be beneficial for social and economic life of human beings. The report highlights the costs and opportunities in tackling global climatic changes in the first part. The review considers recent developments and their effects on human life and environment. The cost of allowing unbridled climatic changes will be about 20 per cent of GDP. On the other hand, the cost of reducing greenhouse gases will amount to 1 per cent of global GDP. If we do not take care of carbon emissions, each ton of carbon dioxide emitted will cause damage worth $85. Studies show that this can be restricted to $25 per ton through global strategies. Thus, reducing emissions will also be beneficial for our economic growth. The review also estimates that the market for low carbon products is estimated at $500 billion or perhaps much more by 2050. Thus, tackling climate change is definitely a pro-growth strategy.

The negative consequences of global warming are catastrophic. These include:

- Increasing drought and desertification
- Crop failures
- Melting of the polar ice caps
- Coastal flooding
- Displacement of major vegetation regimes
- Coral mortality
- Change in ocean behaviour
- Natural disasters
- Infectious diseases
- Degradation of ecosystems
- Scarcity of food supply
- Rise in sea level

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To address the detrimental effects, corrective measures with regard to the following need to be taken:

- Cutting down on carbon monoxide emissions
- Adopting the Clean Development Mechanism suggested under the Kyoto Protocol
- Reducing green house effect
- Using cleaner mining technologies that will reduce sulphur dioxide and particulate pollution thereby lowering mining contamination of water and air

Implications of Climate Change for Development

There is growing awareness and many studies show that climate change is leading to reduction in economic growth and development especially in Asia and Africa (Stern, 2007; Biemansetal., 2006). Climate change may lead to bringing down the GDP in India by 10 per cent by 2100 in comparison to a condition without climate change (Stern, 2007). The Stern review also identifies that in particular the combination of a gradually declining environment and the shock of extreme events will affect growth. The extreme events will knock back years of growth while the declining environment will slow down development between extreme events and decrease the resilience to manage the impacts of extreme events.

Historic events reveal that droughts and heavy floods had a major impact on the economy of developing countries. During the events like droughts or floods, the government revenue is often reduced due to the less output; while the expenditure needs to be increased to supply food aid and repair the damaged infrastructure. Future climate change is expected to increase the number of floods and droughts that will reduce government incomes and increase expenditure with a bad impact on budgets.

The impacts on growth are expected to be different among various countries. Some countries are presently undergoing fast growth. These countries are expected to be more ready than countries with slow or no growth. The so called 'least developed countries' could see their vulnerabilities increase manifold.

Let us now see the other set of issues related to globalization and environment. It is important to realize that the environment has the power to affect the pattern of globalization as well.

- Due to globalization, our economic activities have grown at a fast pace and are causing considerable environmental damage, some of which are irreparable.
- Our burning of fossil fuels at greater rates is contributing to global climate change. We do not even know what the full consequences of climate change may be, but we know that these may be severe.

- Sea levels could rise.
- Extreme weather conditions could become more common. Weather patterns could shift. Some species could perish.
- Rapid destruction of the world's tropical rainforests; over-fishing of oceans; diminishing sources of fresh water.
- Environmental degradation may result in large-scale desertification and loss of agricultural land.
- Can cause great despair and frustration at individual level as people may stand to lose their livelihood (farmers and fishermen).
- Environmental degradation can bring in various diseases.
- Insurance companies will be plagued as communities suffer from severe weather conditions, such as flood, draught, hurricanes, etc.
- It can also increase ethnic tensions in regions that already lack natural resources.

A fine balance between economic development and environmental requirements makes for a self-sustaining model that survives into the future. Suggestions include creating increased public consciousness about the issue; explaining the concept of environmental conservation; highlighting the dangers of environmental devastation, particularly from the historical perspective; and actively exploring the possibility of incorporating self-sustaining eco-systems within our daily work cycles.

Cost of Climate Change in Developed Countries

We acknowledge that estimating abatement (or 'mitigation') costs is very complex in nature. To begin with, the costs are lower if the world adopts the cheapest emission-reduction technologies first and the highest-cost technologies last—but we have no guarantee the world shall act that way. Costs are projected in different ways. Generally, they are based on the direct costs of the technologies, e.g., the cost of construction of a nuclear power station. Nonetheless, several other types of costs are involved and technology costs do not necessarily communicate with the right concept of cost which is measured by the 'welfare' losses incurred to customers and producers. The costs can differ significantly; depending on the compliance policies. For example, the market-based instruments, such as carbon taxes and tradable permits, are thought to have lesser compliance costs than simply telling emitters what technology to use through 'command and control'. It is for this cause that so much emphasis is being placed on the latest policies like permit trading systems. Many economic specialists consider that costs will be lower than projected because the emitters will find new technologies and the cheaper ways of overcoming problems of climate regulation. But some others consider that there are many unseen costs in regulation, so that real costs may turn out to be higher than projected. For all these causes, and others, we would expect broad variations in the estimates of controlling costs.

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Check Your Progress

1. What does the means-end relationship state?
2. Define climate.
3. What does the Stern review state on climate change?

3.3 OZONE DEPLETION

The ozone layer is a thin layer in the atmosphere, made up of oxygen atoms (O3) that absorb harmful ultraviolet radiation (UV-B) from reaching the earth's surface. The ozone is being depleted by chemicals released into the atmosphere like chlorofluorocarbons (CFCs), carbon tetraflouride, methyl chloroforms, chlorofluoromethanes (aerosol repellents and as refrigerants). The problem is when CFCs reach the ozone layer, it is broken down by the UV -B rays and it is these free chlorine atoms that do the damage to ozone. One free chlorine atom will destroy 100,000 ozone molecules before it dies off.

Scientists have discovered a hole in the ozone layer over Antarctica and some mid-altitude regions over Chile in South America. The Mapuche Nation lives under one of these holes in the ozone and they have seen an increased number of skin cancer and blindness among their people. They see a huge impact to the plants and animals in their surrounding environment.

Scientists believe that species on earth will have to adjust their UV-B composition in order to survive. Humans can put on sunscreen to protect them from the UV-B rays but animals and plants will have a hard time surviving. Plus the addition of UV-B rays will heat the earth's surface, which adds to global warming.

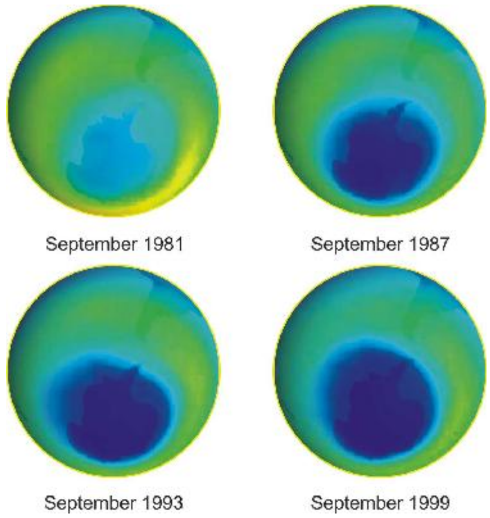


Fig 3.1 *Varying Size of the Ozone Hole over Antarctica*

3.3.1 How It Happens

About 90 per cent of the atmospheric ozone is in the stratosphere from 10 to 50 km and is known as ozone layer. The rest 10 per cent of ozone is in the troposphere. Ozone is beneficial when it is in the stratosphere by protecting us from the harmful UV rays, as it helps in formation of photochemical smog in the troposphere. It needs to be mentioned here that the photochemical smog formation is mainly due to human activities. Thus, ozone is mainly beneficial for us.

Ozone absorbs all the solar ultraviolet radiations of wavelength less than 290 nm and negligibly absorbs those in between 290 to 350 nm.

Ozone is continuously created in the stratosphere and at the same time continuously removed. Thus, there is an apparent equilibrium in the ozone region with the concentration of ozone remaining constant.

A satellite data, however, indicated damage to the stratospheric ozone layer over Antarctica, a hole of the size of a big continent. The main chemicals responsible for depletion of ozone layer were found to be chlorofluorocarbons (CFCs) and especially $CFCl_2$, CF_2Cl_2, $C_2F_3Cl_3$ and chloroflouro bromine (CF_3Br).

Another potent ozone depleting gas is methyl bromide (CH_3Br), which is used in agriculture to sterilize soil and fumigate crops after harvesting. Greater concentration of NO_2 if present in the upper atmosphere (main source, jet planes) may also destroy ozone.

In the Arctic, the combination of land and ocean maintains warmer temperature and atmospheric conditions are not as in Antarctica and, thus, there is lesser thinning of ozone layer over the Arctic in spring.

However, it is of great concern that due to troposphere warming by greenhouse gases, there is a possibility of stratospheric cooling which ultimately might lead to same atmospheric condition in Arctic like the Antarctic and cause dramatic ozone layer depletion.

Depletion of ozone layer will lead to increase in the flux of UV radiation over the biosphere of the earth. This ultimately will lead to:

- skin cancer
- eye and lung irritation
- reduced photosynthesis
- affects crop productivity
- affects weather patterns through interference with oxygen.

The depletion of ozone (O_3) molecule by CFC can be depicted as below:

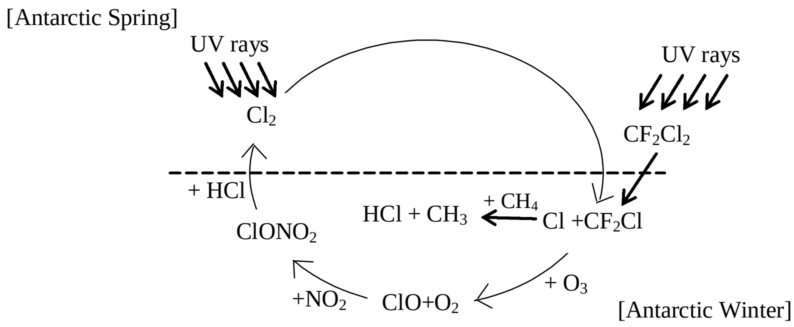


Fig 3.2 Ozone Depletion by CFC

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3.3.2 Halocarbons

This class of carbon compounds is based with chlorine, fluorine or bromine in them. Chlorofluorocarbons (CFCs) are commonly called Freon gases and bromofluoro carbons are called Halons. These gases do not occur naturally and are entirely created by human activities. Carbon tetrachloride (CCl_4), methyl bromide (CH_3Br), methyl chloroform (CH_3CCl_3) are also halocarbons but the latter two are better to form hydrobromocarbon and hydrochlorocarbon. Chlorofluorocarbons (CFCs) are non-toxic, non-flammable, non-reactive and are insoluble in water. As they are inert and water insoluble, they cannot be destroyed by chemical reactions or cannot be removed by rain.

Thus, they have a long lasting life in the atmosphere. These molecules absorb approximately 9 ìm with some bending and stretching bands in the vicinity of atmospheric window, making these as potent greenhouse gases.

Halocarbons are responsible not only for their contribution to global warming, but also for their ability to deplete ozone layer in the stratosphere. Chlorofluorocarbons, because of their easy liquefaction under pressure and when pressure is released produce very cold temperature. Also because of their non-toxic character they are used as refrigerants to replace toxic, noxious, highly inflammable gases like CO_2, CH_3Cl, SO_2, NH_3, etc.

Uses

- Refrigerant and air conditioners
- Foam products
- Fire extinguishers
- Solvents in cleaning action
- Pesticides.

Classification of Halocarbons

(1) *Chlorofluorocarbons (CFCs)*: These compounds have carbon, fluorine and chlorine but no hydrogen. For example,

$CFCl_2$

$CF2Cl_2$

(2) *Hydrochlorofluorocarbons (HCFCs)*: These compounds have carbon, chlorine, fluorine, as well as hydrogen. For example,

$CHF_2\ Cl$

CH_2CFCl_2

(3) *Hydrofluorocarbons (HFCs)*: These compounds have carbon, hydrogen and fluorine but no chlorine. For example,

CH_3CF_3

CH_2CH_2F

(4) *Halons*: These compounds have carbon with bromine and fluorine and occasionally chlorine. For example,

CF_3Br

CF_2ClBr

There are other types of halocarbons like carbon tetrachloride (CCl_4), tetrafluromethane (CF_4).

Chlorofluorocarbons are known to be potent destroyers of the ozone layer in the stratosphere. So, hydrochlorofluorocarbons came as replacement of CFCs. Hydrochlorofluorocarbons, due to the presence of hydrogen bond undergo chemical reactions and in the process get destroyed in the troposphere, thus cannot reach the stratosphere to affect ozone. Its ozone depletion potential is 2–5 per cent of most commonly used CFC-11 and CFC-12. Hydrofluorocarbons having no chlorine atom can be much better replacement.

Hydrochlorofluorocarbon (HCFC)

This is an alternative to fully halogenated CFC. Due to the presence of hydrogen bond, such compounds will be less stable compared to CFC and are less likely to reach stratosphere affecting ozone layer. The ozone depletion potential of HCFC is only 2 to 5 per cent of the most commonly used CFC.

3.3.3 International Conventions for Protection of Ozone Layer

To address the issue of depletion and protection of ozone layer, international conventions at Vienna and Montreal were held. Let us discuss them here.

Vienna Convention for the Protection of the Ozone Layer

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The ozone layer, found in the stratosphere about 10–50 km above the ground, protects us from the harmful effects of certain wavelengths of the Ultra-Violet (UV) rays of the sun. The sun rays especially the UV-B radiation can result in increased risk of skin cancers, reduced immunity and other illnesses. The rest of the animal kingdom is also affected by the depletion of ozone layer. Ozone depletion is caused by chlorofluorocarbons (CFCs), which are used in aerosols, foams, refrigeration, air conditioners, solvents, fire extinguishers and so on. The discovery of the Ozone Hole, confirmed the depletion of the ozone layer over the Antarctic in 1985.

The Vienna Convention was adopted on 22 March 1985 and entered into force on 22 September 1988. As per the Vienna Convention, the parties agree to take appropriate measures to prevent the modification of the ozone layer. However, the appropriate measures in this regard are not unspecified. The main thrust of the convention was to encourage research, cooperation among countries and the exchange of information. The Vienna Convention represented the first instance when nations agreed to address a global environmental problem even before it was scientifically established.

The obligations under the Vienna Convention include the following.

- A member must cooperate in the observation, research and information exchange on ozone layer depletion and its impact on human health and the environment.
- It must also cooperate in the international efforts to formulate and implement the ozone regime.
- It must initiate and cooperate in the conduct of research and scientific observations.
- It must also cooperate in legal, scientific and technical fields and transmission of information on the measures adopted by them in the implementation of this convention.
- It must adopt legislative and administrative measures to control, limit, reduce or prevent human activities that have an adverse effect on the ozone layer.

Montreal Protocol on Substances that Deplete the Ozone Layer

After the fact of ozone depletion was confirmed in a paper published in May 1985 by the British scientists followed by observations by the American satellites, the Montreal Protocol was signed on 16 September 1987. The Montreal Protocol, which entered into force on 1 January 1989, outlined the specific measures to be taken in order to control the use of Ozone Depleting Substances (ODSs). The protocol aims to reduce and eventually eliminate the emissions of man-made ODSs. Since its adoption, the Montreal Protocol has been modified five times through

adjustments and amendments. Its control provisions were strengthened in London (1990), Copenhagen (1992), Vienna (1995), Montreal (1997) and Beijing (1999). Under the Montreal Protocol, a member agrees to take precautionary measures to control the emissions of ODSs, with the ultimate objective of their elimination. The emission reduction obligations are laid out in detail in the protocol.

Check Your Progress

4. What is ozone layer?
5. What is the aim of the Montreal Protocol?

3.4 BIODIVERSITY

The earth holds a vast variety of living organisms, which includes different kinds of plants, animals, insects, and microorganisms. It has an immense variety of habitats and ecosystems. The total diversity and variability of living things and of the system of which they are a part is generally defined as biological diversity, i.e. the total variability of life on Earth. Biodiversity includes diversity within species, between species and of ecosystems.

Perception of biodiversity varies widely among biologists, sociologists, lawyers, naturalists, conservationists, ethno biologists and so on. Thus, biodiversity issues have been a unifying force among people of various professions and pursuits.

Conservation is the protection, preservation, management, or restoration of wildlife and natural resources such as forests and water. Through the conservation of biodiversity, the survival of many species and habitats which are threatened due to human activities can be ensured. Other reasons for conserving biodiversity include securing valuable natural resources for future generations and protecting the functions of the eco-system.

Levels of Biodiversity

Biodiversity can be studied at many levels.

1. Genetic biodiversity

It is the basic source of biodiversity. Genes found in organisms can form enormous number of combinations, each of which gives rise to some variability. Genes are the basic units of hereditary information, transmitted from one generation to other. When the genes within the same species show different versions, due to new combinations, it is called genetic variability. For example, all rice varieties belong to the species Oryza sativa, but there are thousands of wild and cultivated varieties of rice which show variations at the genetic level and differ in their colour, size, shape, aroma and nutrient content of the grain. This is genetic diversity of rice. Genetic biodiversity means the variation of genes within a species. In a species,

each variety has its own genes or genetic make-up. Diversity of genes within a species increases its ability to adapt to disease, pollution and other changes in environment. When a variety of a species is destroyed, genetic diversity gets diminished.

2. Species biodiversity

This is the variability found within the population of a species or between different species of a community. It represents broadly the species richness and their abundance in a community. Till now, only about 1.5 million living and 300000 fossil species have been actually described and given scientific names. It is quite likely that a large fraction of these species may have become extinct even before they were discovered and enlisted. Species biodiversity means a variety of species within a region. Such diversity can be measured on the basis of species in a region. More the species biodiversity means more the biological wealth.

3. Ecosystem biodiversity

Ecosystem biodiversity is the diversity that shows variations in ecological niches, nutrient cycling, tropic structure, food webs, etc. There is variation in physical parameters like moisture, temperature, altitude and precipitation. Thus, there is tremendous variation within the ecosystems along these gradients.

Variations in trees and wildlife found in forests are due to these physical factors. Ecosystem diversity is of great importance and should be kept intact. This diversity has developed over millions of years of evolution. Destruction of this diversity will result in ecological imbalance. It is impossible to replace the diversity of one ecosystem with that of another. Coniferous trees of boreal forests cannot take up the function of the trees of tropical deciduous forest lands and vice versa as this is the result of the prevailing environmental condition of that particular area with well-regulated ecological balance.

Principles of Biodiversity

Biodiversity in terms of its commercial utility, ecological value, social and aesthetic value has enormous importance. We are benefited by other organisms in many different ways. Sometimes, we come to know and appreciate the value of an organism only after it is lost from this earth. All organisms have their importance and role to play in keeping the ecological. The multiple principles of biodiversity are classified as follows:

1. Consumptive use value

These include direct use values where the biodiversity product can be harvested and consumed directly, e.g., fuel, food, drugs and fibre.

Food: A large number of wild plants and shrubs are consumed by human beings as food. Many edible plants species have been taken up for farming.

Agricultural scientists develop new hardy strains of different plant species that are available in the wild. A large number of wild animals are also our sources of food.

Drugs and medicines: About 75 per cent of the world's population depends on plants or plant extracts for medicines. For example, penicillin drug used as an antibiotic is derived from a fungus called penicillin and quinine, the cure for malaria is obtained from the bark of cinchona tree. Recently, vinblastin and vincristine, two anti-cancer drugs, have been obtained from periwinkle (catharanthus) plant, which possesses anti-cancer alkaloids.

Fuel: Our forests have been a big supplier of fuel wood. Fossil fuels like coal, petroleum and natural gas are products of fossilized biodiversity. Firewood collected by people is not normally marketed, but are directly used by tribals and local villagers; hence, falls under constructive value.

2. Productive use values

These are the commercially usable values that can be marketed and sold. These products can range from lumber or wild gene resources used by scientists for introducing desirable traits in crops and domesticated animals or animal products like tusks of elephants, musk from musk deer, silk from silkworm, wool from sheep, and lac from lac insects. Many industries are dependent on the productive use of values of biodiversity like paper and pulp industry, plywood industry, railway sleeper industry, silk industry, and textile industry.

3. Social value

These are the values associated with the social life, customs, religion and psycho spiritual aspects of the people. Many plants like *tulsi*, *peepal* and lotus are considered holy and sacred in our country. The leaves, fruits or flowers of some particular plants are used in worship or the sometimes the plant itself is worshipped, like the plant of *tulsi*. The tribal people have close links with the wildlife in the forest. Their social life, songs, dances and customs are closely woven around the wildlife. Animals like cow, snake, peacock and owl also have a significant place in our psycho-spiritual arena and therefore are of social importance. Thus, biodiversity has distinct social value, attached with different societies.

4. Ethical value

Ethical value is also sometimes known as existence value and is based on the concept of 'live and let live'. If we must protect all biodiversity as biodiversity is valuable and important for human race to survive.

Ethical value means that we may or may not use a species, but are happy with the fact that they exist in the nature. One feels sorry when any particular species like 'passenger pigeon' or 'dodo' become extinct. This means, there is an ethical value or existence value attached to each species.

5. Aesthetic value

Great aesthetic value is attached to biodiversity. None of us would like to visit vast stretches of barren lands with no signs of visible life. Most people like to spend their time in the lapse of nature and in wilderness. They enjoy the aesthetic value of biodiversity. This type of tourism has come to be known as ecotourism. The concept 'willingness to pay' on such ecotourism gives us a monetary estimate for aesthetic value of biodiversity.

6. Option value

These values include the potential of biodiversity that are presently unknown and need to be explored. It is the knowledge that there are biological resources that may prove to be effective some day in future. Option value also includes the values, in terms of the option to visit areas where a variety of flora and fauna, or specifically some endemic, rare or endangered species exist.

7. Ecosystem service value

This refers to the services that can be rendered to preserve the ecosystems like maintenance of soil fertility, prevention of soil erosion, prevention of floods, fixation of nitrogen, cycling of water, cycling of nutrients, pollutant absorption and reduction of the threat of global warming, etc. Different categories of biodiversity value indicate that there is enormous potential in ecosystem, species and genetic diversity and a decline in biodiversity will lead to huge economic, ecological and socio- cultural losses.

Biogeographical Classification of India

India has different types of climate and topography in different parts of the country and these variations have induced enormous variability in flora and fauna. India has a rich heritage of biological diversity and occupies the tenth position among the plant rich nations of the world.

It is very important to study the distribution, evolution, dispersal and environmental relationship of plants and animals in time and space. There are ten different bio-geographic habitats in India.

1. Trans-Himalayan – Upper regions
2. Himalayan – North-West Himalayas, West, Central and East Himalayas
3. Desert – Kutch, Thar and Ladakh
4. Semi-Arid – Central India, Gujarat-Rajwara
5. Western Ghats – Malabar Coast, Western Ghat Mountains
6. Deccan Peninsula – Deccan Plateau South, Central, Eastern, Chhota Nagpur
7. Gangetic Plain – Upper Gangetic Plain, Lower Gangetic Plain

8. North-East India – Brahmaputra Valley, North Eastern Hills
9. Islands – Andaman Islands, Nicobar Islands, Laskhadweep, etc.
10. Coasts – West Coast and East Coast

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Global Biodiversity

The United Nations Conference on Environment and Development at Rio in 1992, put biological diversity on the international agenda by signing the Convention on Biological Diversity (CBD). This convention addresses many issues ranging from forests, agriculture to Intellectual Property Rights (IPRs). India is a signatory to CBD and ratified it in 1993. The Government of India has finalized the National Policy and Action Strategy for Biodiversity. A legislation was finalized and the Indian Parliament passed the Biodiversity Bill in 2002. The objective of the convention was 'the conservation of biological diversity, the sustainable use of its components and equitable sharing of benefits arising out of the utilization of genetic resources.' It also covered the ecological, economic and social aspects of biodiversity.

The success of the convention can be evaluated in two main ways:

The first one is by the analysis of the changes in components of biodiversity (i.e., species and ecosystems) and by measuring the effectiveness of the measures taken to implement the convention. According to the Worldwide Fund for Nature, scientists have identified about 1.4 million species. Of these, around 1.03 million are animals and 2,48,000 are higher plants. But, human knowledge of the world's biodiversity is still not complete. Higher plants have also been fairly well studied, but it is possible that 15 per cent more may still be discovered. Numerous insects, invertebrates, lower plants and micro-organisms exist, but have yet to be identified and described. One recent estimate put this figure as high as 30 million.

Human impact on nature has reached such high proportions that the world is today witnessing an extraordinary rate in loss of species. Many thousands of species will disappear even before they are found as described by biologists. In 1988, the International Union for Conservation of Nature (IUCN) listed 4,589 threatened animals. Scientists at the Kew Gardens in Britain listed around 20,000 plant species as threatened. According to an estimate by the IUCN's Threatened Plants Unit, by the year 2050 up to 60,000 plant species will become extinct or threatened. These estimates show that the current rate of extinction is at least 25,000 times greater than the extinction that took place during evolutionary times. The rate of extinction of mammals alone has risen from one species every five years in the seventeenth century to one every two years in the twentieth century.

Biological Diversity at National Level

Every country is characterized by its own biodiversity which mainly depends on the climate. India has a rich biological diversity of flora and fauna. Overall six per cent of the global species are found in India. The total number of living species

identified in India is 1,50,000. Out of the total 25 biodiversity hot spots of the world, India possesses two— one in the northeast region and one in the Western Ghats. India is also one of the 12 mega-biodiversity countries in the world.

India as a Mega-Diversity Nation

India is one of the twelve mega-diversity countries in the world. The Ministry of Environment and Forests, Govt. of India (2000), records 47,000 species of plants and 81,000 species of animals which is about 7 per cent and 6.5 per cent respectively of global flora and fauna. These major groups of species include endemism, centre of origin, marine diversity, etc. A large proportion of the Indian biodiversity is still unexplored. Due to its diverse climatic conditions, there is a complete spectrum of biodiversity in our country.

3.4.1 Threats to Biodiversity

Extinction or elimination of a species is a natural process of evolution. The rate of loss of species in the geologic past has been a slow process but the process of extinction has become particularly fast in the recent years of civilization. In the recent times, the human impact has been so severe that thousands of species and varieties are becoming extinct annually.

The following are the major causes and issues related to threats to biodiversity:

- **Loss of Habitat**

Destruction and loss of natural habitat is the single largest cause of losing biodiversity. Billions of hectares of forests and grasslands have been converted into agricultural land, pastures, settlement areas or for development projects. These forests and grasslands were the homes of thousands of species, which perished due to loss of their natural habitat. There has been severe damage to the wetlands which were thought to be useless ecosystems. They are getting destroyed due to draining, filling and pollution causing huge loss of biodiversity.

The habitat is divided into small and scattered patches, so that the complete loss of habitat can be put at bay. This phenomenon is known as habitat fragmentation. There are many wildlife species such as bears and large cats that require large territories to live but are threatened as they breed only in the interiors of the forests. Marine diversity is also under serious threat as there is due to large-scale destruction of the breeding and feeding grounds of fish and other species.

- **Poaching**

Illegal trade of wildlife products by killing prohibited endangered animals is another threat to the wildlife. The rich countries in Europe and North America and some affluent countries in Asia like Japan, Taiwan and Hong Kong are the major importers of wildlife products or wildlife itself. The trading of such wildlife products is highly profitable for the poachers who smuggle them to other countries mediated through mafia.

- **Man-Wildlife Conflicts**

As we know that it is very important to preserve and protect wildlife but sometimes we come across situations when wildlife causes immense damage and danger to man. Under such conditions it becomes difficult for the forest department to pacify and gain local support for wildlife conservation from the people or villages that are affected by the wildlife.

Instances of man-animal conflicts come to limelight from several states in our country time and again. In Sambalpur, Odisha, 195 humans were killed in the recent past by elephants. In retaliation, the villagers killed ninety-five elephants in the border region of Kote-Chamarajanagar belt in Mysore. The conflict in this region has arisen because of massive damage done by the elephants to the cotton and sugarcane crops. The elephants are electrocuted by the villagers or blown off with explosives when they intrude into the fields. In fact, more killings are done by locals than by poachers. In early 2004, a man-eating tiger was reported to have killed sixteen Nepalese people and a four year old child inside the Royal Chitwan National Park, 240 km South-west of Kathmandu. Similar incidents were reported near Sanjay Gandhi National Park, Borivali, Mumbai where similar incidents of human killings, especially of small children was reported.

Causes of Man-Animal Conflicts

- Dwindling habitats of tigers, elephants, rhinos and bears due to shrinking forests cover are compelled to move outside the forests. Human encroachment into the forest areas has rendered all forest living animals to trespass the borders of human civilizations. This is because the conflicts between man and the wildlife have increased since it is an issue of survival of both.
- Weak and injured animals have a tendency to attack man. At times, a tigress might attack the human if she feels that her cubs are in danger. It is very difficult to trace a man-eating tiger and in the process many innocent tigers get killed.
- Earlier, the forest department used to cultivate crops like paddy, and sugarcane within the sanctuaries as they are a favourite of elephants. Due to lack of such practices the animals tend to move out of the forest in search of food. It may be noted that, one adult elephant needs 2 quintals of green fodder and 150 kg of clean water daily and if it is not available, the animal will leave its habitat in search of it.
- Very often, the villagers put electric wiring around their ripe crop fields. The elephants get injured, suffer pain and may then turn violent.
- Disappearance and disruption of wildlife corridor due to development has given the animals a chance to attack humans.

- The cash compensation paid by the government in lieu of the damage caused to the crops by the wild animals is not enough. The affected farmer, therefore, gets revengeful and kills the wild animals.

Remedial Measures to Curb the Conflict

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- Tiger Conservation Project (TCP) has made provisions of vehicles, tranquillizer guns, binoculars and radio sets, etc., to deal with any imminent danger tactfully.
- There should be adequate crop compensation and cattle compensation schemes along with substantial cash compensation for loss of human life.
- Solar-powered fencing should be provided along with electric current proof trenches to prevent animals from straying into the agricultural fields.
- Cropping pattern should be changed near the forest borders and adequate amount of food and water should be made available to the animals.
- Wildlife corridors should be provided for mass migration of big animals during unfavourable periods.
- Rituals such as wild animal hunting like 'Akhand Shikar', practiced in Similipal Sanctuary, Odisha should be banned.

Endangered and Endemic Species of India

India is home to a number of species that are facing various degrees of extinction. The IUCN Red List of Threatened Animals is internationally recognized as the list that categorizes the status of globally threatened animal species. Based on the numbers and the level of threat, the species have been classified into the following groups:

- **Critically endangered**

Animals in this category face the highest risk. Critically endangered means that a species' numbers have decreased, or will decrease, by 80 per cent within three generations. There are 18 critically endangered animal species in India, including the Ganges shark, Himalayan wolf, Indian vulture and pygmy hog.

- **Endangered**

A species is said to be endangered when its population is at risk of becoming extinct because it is either few in numbers, or threatened by changing environmental or predation parameters. There are 54 endangered species in India, including Asiatic lion, chiru (Tibetan antelope), Ganges dolphin, Indian rhinoceros, Indian elephant, Royal Bengal tiger, Nilgiri tahr, Olive Ridley turtle, red turtle, snow leopard, etc.

- **Vulnerable**

A vulnerable species is one which has been categorized as likely to become endangered unless the circumstances threatening its survival and reproduction improve.

- **Threatened**

Threatened species are any species (including animals, plants, fungi, etc.) which are vulnerable to endangerment in the near future. In addition to the animals, nearly 450 plant species have been identified in the categories of endangered.

India is also rich in endemic species. Endemic species are those that are found in specific locations and nowhere else in the world. The biodiversity hotspots in India are rich in endemic species. The Western Ghats are the richest in endemic species, with about 62 per cent of the known amphibian species and nearly 50 per cent of the lizards of India being endemic to this region. There are 42 species of endemic birds in India, out of which 35 are found in the Western Ghats. About 30 per cent of the world's recorded flora is endemic to India. Most of these endemic species are found in the Himalayas and adjoining regions and in the Western Ghats. Endemic mammals of India include lion-tailed macaque, Nilgiri langur, brown palm civet and Nilgiri tahr.

3.4.2 Conservation of Biodiversity

Due to the tremendous importance of biodiversity it is considered an asset of a region or a nation. Due to its multiple advantages of commercial value, consumption value, medicinal value, social, cultural, religious and optional values, biodiversity needs to be conserved. The need for its protection and conservation has become more important due to overexploitation and the subsequent depletion. There are two types of methods of conservation of biodiversity:

- Ex-situ
- In situ

Ex-situ conservation means off-site protection of biodiversity. It is the process of protecting an endangered species of plant or animal by removing it from an unsafe or threatened habitat and placing it under human care. While Ex-situ conservation comprises some of the oldest and best-known techniques known to and created by man, it also involves newer techniques like laboratory method.

Ex-situ conservation

Creation of zoos, botanical gardens, culture collection centres are the most conventional and traditional methods of ex-situ conservation, all of which house and protect specimens for breeding and reproduction of wild life animals and plants. Endangered plants may also be preserved in part in such botanical garden through seed banks and germ plasma banks. Endangered animals are preserved

using similar techniques through preservation in gene bank. In the gene banks, which consist of cryogenic facilities, live sperms, eggs or embryos can be stored. Some countries have established frozen zoos to store such samples from more than 366 species, which consist of mammals, reptiles and birds.

Drawbacks of ex-situ conservation: Ex-situ conservation although is helpful to man's effort to sustain and protect biodiversity, is rarely enough to save a species from extinction. It can be used as a last resort or as a supplement to in-situ conservation. It cannot re-create a habitat. Furthermore, ex-situ conservation techniques are often costly natural.

In-situ conservation

In-situ conservation means to conserve the biodiversity within the habitat and on site. It deals with the protection of an extinct species of plant or animal in its natural habitat, either by protecting or preventing the habitat itself from getting exhausted. The benefit of in-situ conservation is that it maintains the natural surroundings of the population of the animals or plant in its natural distinctive property. In situ conservation should be preferred to ex-situ conservation, the latter opted only in case where in situ conservation is either too difficult or impossible. Wildlife conservation is mostly based on in situ conservation through protection and recreation of the wildlife habitat.

Check Your Progress

6. What do you mean by genetic variability?
7. Give a brief note on the biological diversity of India.
8. How did the Convention of Biological Diversity, 1992 define biodiversity?
9. What are the three levels of biodiversity?
10. What is the ethical value of biodiversity?
11. What are the two hot spots of biodiversity in India?

3.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The means-end relationship enjoins that our actions should be ethically as good as the means.
2. Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in a region.
3. The Stern review maintains that though all countries have to suffer due to climate change, it is the poorest that will suffer the most. However, any positive international action will help slow down this change.

4. The ozone layer is a thin layer in the atmosphere, made up of oxygen atoms (O_3) that absorb harmful ultraviolet radiation (UV-B) from reaching the earth's surface.
5. The Montreal Protocol aims to reduce and eventually eliminate the emissions of man-made Ozone Depleting Substances (ODSs).
6. When the genes within the same species show different versions, due to new combinations, it is called genetic variability. For example, all rice varieties belong to the species Oryza sativa, but there are thousands of wild and cultivated varieties of rice which show variations at the genetic level and differ in their colour, size, shape, aroma and nutrient content of the grain.
7. Every country is characterized by its own biodiversity depending mainly on its climate. India has a rich biological diversity of flora and fauna. Overall, 6 per cent of the global species are found in India. It is estimated that India ranks tenth among the plant rich countries of the world, eleventh in terms of the number of endemic species of higher vertebrates and sixth among the centres of diversity and origin of agricultural crops.
8. In the Convention of Biological Diversity, 1992, biodiversity has been defined as the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part of.
9. Biodiversity means the variety and variability of all living organisms. Biodiversity constitutes the biological wealth. Biodiversity is at three levels genetic diversity, species diversity and ecosystem diversity.
10. It is also sometimes known as existence value. It involves ethical issues like 'all life must be preserved'. It is based on the concept of 'live and let live'. If we want our human race to survive, then we must protect all biodiversity, because biodiversity is valuable.
11. There are twenty-five such hot spots of biodiversity on a global level, out of which two are present in India, namely the Eastern Himalayas and the Western Ghats.

3.6 SUMMARY

- Global warming and climate change are perhaps considered to be the greatest threat to the planet. Global warming is threatening the existence of life on this planet. Global warming affects climate in such a manner that it intimately becomes related with our economic, social and political activities.
- The past acts of the developed countries have contributed to immense global warming resulting in heavy carbon dioxide emissions. The way global warming impacts the atmosphere is highly complex.

NOTES

- The ethic of means and end relationship which Gandhi has espoused seems to be vital for environmental problems and its solutions. The means-end relationship enjoins that our actions should be ethically as good as the means.
- Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period, for at least thirty years is called climate.
- The Intergovernmental Panel on Climate Change (IPCC) in 1990 and 1992 published the best available evidence about past climate changes, the greenhouse effect and recent changes in global temperature.
- Heat trapped by greenhouse gases in the atmosphere keeps the planet warm enough to allow us and other species to exist. The two predominant greenhouse gases are water vapour which is controlled by the hydrological cycle and carbon dioxide which is controlled mostly by the global carbon cycle.
- Climate change is a serious challenge faced by the international community striving towards sustainable development. It has implications for not only health and well-being of the earth's ecosystem but also for the economic enterprises and social livelihood.
- One of the most significant reviews on the economics of climate change is the Stern review. The review maintains that though all countries have to suffer due to climate change, it is the poorest that will suffer the most. However, any positive international action will help slow down this change.
- Historic events reveal that droughts and heavy floods had a major impact on the economy of developing countries. During the events like droughts or floods, the government revenue is often reduced due to the less output; while the expenditure needs to be increased to supply food aid and repair the damaged infrastructure.
- The costs are lower if the world adopts the cheapest emission-reduction technologies first and the highest-cost technologies last—but we have no guarantee the world shall act that way.
- The ozone layer is a thin layer in the atmosphere, made up of oxygen atoms (O_3) that absorb harmful ultraviolet radiation (UV-B) from reaching the earth's surface. The ozone is being depleted by chemicals released into the atmosphere like chlorofluorocarbons (CFCs), carbon tetraflouride, methyl chloroforms, chlorofluoromethanes (aerosol repellents and as refrigerants).
- Ozone is beneficial when it is in the stratosphere by protecting us from the harmful UV rays, as it helps in formation of photochemical smog in the troposphere. It needs to be mentioned here that the photochemical smog formation is mainly due to human activities.

- Halocarbon compounds are based with chlorine, fluorine or bromine in them. Chlorofluorocarbons (CFCs) are commonly called Freon gases and bromofluoro carbons are called Halons. These gases do not occur naturally and are entirely created by human activities.
- The Vienna Convention was adopted on 22 March 1985 and entered into force on 22 September 1988. As per the Vienna Convention, the parties agree to take appropriate measures to prevent the modification of the ozone layer.
- The Montreal Protocol, which entered into force on 1 January 1989, outlined the specific measures to be taken in order to control the use of Ozone Depleting Substances (ODSs). The protocol aims to reduce and eventually eliminate the emissions of man-made ODSs.
- The total diversity and variability of living things and of the system of which they are a part is generally defined as biological diversity, i.e. the total variability of life on Earth. Biodiversity includes diversity within species, between species and of ecosystems.
- Genetic biodiversity means the variation of genes within a species.
- Ecosystem biodiversity is the diversity that shows variations in ecological niches, nutrient cycling, tropic structure, food webs, etc. There is variation in physical parameters like moisture, temperature, altitude and precipitation. Thus, there is tremendous variation within the ecosystems along these gradients.
- The United Nations Conference on Environment and Development at Rio in 1992, put biological diversity on the international agenda by signing the Convention on Biological Diversity (CBD).
- Human impact on nature has reached such high proportions that the world is today witnessing an extraordinary rate in loss of species. Many thousands of species will disappear even before they are found as described by biologists.
- Destruction and loss of natural habitat is the single largest cause of losing biodiversity. Billions of hectares of forests and grasslands have been converted into agricultural land, pastures, settlement areas or for development projects.
- A species is said to be endangered when its population is at risk of becoming extinct because it is either few in numbers, or threatened by changing environmental or predation parameters. There are 54 endangered species in India.
- There are two types of methods of conservation of biodiversity:
    - o Ex-situ
    - o In situ

3.7 KEY WORDS

NOTES

- **Global warming:** It is a gradual increase in the overall temperature of the earth's atmosphere generally attributed to the greenhouse effect caused by increased levels of carbon dioxide, chlorofluorocarbons, and other pollutants.
- **Carbon cycle:** It is the series of processes by which carbon compounds are interconverted in the environment, involving the incorporation of carbon dioxide into living tissue by photosynthesis and its return to the atmosphere through respiration, the decay of dead organisms, and the burning of fossil fuels.
- **Ozone layer:** It is a layer in the earth's stratosphere at an altitude of about 6.2 miles (10 km) containing a high concentration of ozone, which absorbs most of the ultraviolet radiation reaching the earth from the sun.
- **CFC:** It refers to any of a class of compounds of carbon, hydrogen, chlorine, and fluorine, typically gases used in refrigerants and aerosol propellants. They are harmful to the ozone layer in the earth's atmosphere owing to the release of chlorine atoms on exposure to ultraviolet radiation.
- **Biodiversity:** It is the variety of life in the world or in a particular habitat or ecosystem.
- **Habitat:** It refers to the natural home or environment of an animal, plant, or other organism.

3.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short Answer Questions

1. What kind of special importance does the means-end relationship have in the environmental context?
2. What is the cause of global warming?
3. State the measures to control global warming.
4. What causes the depletion of ozone layer? How does this depletion affect the earth?
5. What are the obligations under the Vienna Convention?
6. Categorize the species on the basis of their number and the level of threat to them.
7. What are the two types of methods of conservation of biodiversity?

Long Answer Questions

1. 'The management of global climate cannot be successfully attempted through economic evaluation.' Elucidate the statement.
2. What are halocarbons? Describe their uses and classification.
3. Illustrate the levels of biodiversity.
4. How does biodiversity in terms of its commercial utility, ecological value, social and aesthetic value have enormous importance? Explain.

3.9 FURTHER READINGS

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UNIT 4 ENVIRONMENT CULTURE AND INDIA

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Structure

4.0 INTRODUCTION

Today, when people throughout the world are perturbed by the degradation of the environment and its disastrous consequences, traditional ethics of nature conservation could be looked upon as a source of inspiration and guidance for a better future. Perhaps no other culture can provide such a profound variety of cultural practices and ecologically sound relationship with nature as the Indian culture. In this unit, we will study about the importance given to the plants, land, trees and animals in Indian culture. Moreover, the part played by the British in degradation of the Indian forests and in formulating the Indian Forest Policy has also been discussed. The British took some of the very strong steps in order to protect environment from degrading and to preserve it for the future generations. But, some of these laws showed their capability on paper and not on the practical grounds. Many laws and acts enacted by the British in our country proved out to be more useful for them as compared to local population. They made several laws so as to make their task easy as by that they were able to make use of the resources and degrade environment comfortably and lawfully. Some of the laws were so as to protect the resources from the natives itself, so that the British can utilize them for their own needs which were to gain as much capital from India as possible. They introduced rail in India so that the resources present in India, especially environmental resources that they were harnessing, can reach easily and quickly to their destination. They made laws for conserving the forest and in the process marked much of the area as the property of the government so that no one could object to the use of these forests by the British. Even if some laws were beneficial for the environment conservation, they were not implemented properly. The laws like Indian Penal Code 1860, and Criminal Procedure Code 1893, were very effective. Moreover, the laws made by the British paved a way for the Indian to think and implement new laws in this field itself. These laws were one of the first

lessons for the Indians to make laws for the protection of the environment in a more polished fashion in the future.

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4.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the value and importance of land, plants, trees and animals in Indian tradition
- Explain the contribution of Indians in past for the conservation of trees
- Discuss the various stages through which Forest policy of India came into existence
- State the influence of the British on Indian forests during the colonial era

4.2 ENVIRONMENT IN THE INDIAN CULTURAL TRADITION

Living in harmony with Nature has been an integral part of Indian culture. This has been abundantly reflected in a variety of traditional practices, religious beliefs, rituals, folklore, arts and crafts, and in the daily lives of the Indian people from time immemorial. The present day global concerns for sustainable development and conservation of natural resources spanning the two decades between the Stockholm Conference of Environment in 1992 and the United Nations Conference on Human Environment and Development (Earth Summit) at Rio de Janeiro in 1992 are of recent origin in comparison to the long tradition and cultural ethos of nature conservation in India.

Virtually all the countries of the world have rich traditions embedded in the ethics of protecting nature. Many ancient cultures tell us how communities lived in harmony with nature, with a tradition of reverence for the elements that constitute ecosystems, drawing their sustenance from natural resources and at the same time protecting the environment that sustains them. Modern man tends to look down upon indigenous people as primitive, backward and superstitious. They may be poor, illiterate, and disadvantaged in many other ways, but they have a tremendous understanding of ecosystems and the factors that sustain them. In the words of Sitakant Mahapatra (1992):

> They still look upon life as a gift to be celebrated; and this ancient Earth as one to be praised, worshipped and also celebrated. They are the one to whom the earth is not something to be used, not a possession or an object for exploitation but a living entity, an object of reverence, and the relationship is one of sacred trust and loving intimacy. For, they believe as much in celebrating one's life in this world as in remembering, adoring and celebrating the world in one's life. The sacred soil of ancestors into which one is born is thus a part of one's fundamental psychic experience of life and is a part of its spiritual dimension. The earth, the land, the village enter into and are secure in racial memory and it is only an ethical imperative to worship the Earth goddess, the Mother Earth.

The worship of Mother Earth is a universal phenomenon in many indigenous cultures. There are innumerable examples of festivals, rituals, songs, and myths that celebrate the gifts of Mother Earth all over the world, revealing the intimate sense of togetherness and harmony that exists between man and nature in tribal societies. An American-Indian community, the Sioux Indians, refused to till the soil because they did not want to wound the body of their mother, the Earth. They would say, 'Must I mutilate her flesh so as to get at her bones? Then I can never again enter into her body and be born again.'

Indigenous people in many countries attribute supernatural powers to plants, animals, rivers, oceans, mountains, the wind, sun and moon. Respect for nature is inherent in many religious faiths. Many Hindu gods and goddesses are shown to use animals as mounts. Sacred groves or sacred forests preserved with reverence have been part of Hindu and Buddhist culture. In Christianity as well as in Islam, conservation of the environment is based on the principle that nature and its components are created by God, and humans are entrusted with the responsibility of protecting it. Many religions and moral philosophies have professed the unity of all life on earth and the obligation of human beings to care for them.

The Indian Tradition

For the people of India, environmental conservation is not a new concept. Historically, the protection of nature and wildlife was an ardent article of faith, reflected in the daily lives of people, enshrined in myths, folklore, religion, arts, and culture. Some of the fundamental principles of ecology-the interrelationship and interdependence of all life-were conceptualized in the Indian ethos and reflected in the ancient scriptural text, the *Isopanishad,* over 2000 years ago. It says, 'This universe is the creation of the Supreme Power meant for the benefit of all his creation. Each individual life-form must, therefore, learn to enjoy its benefits by forming a part of the system in close relation with other species. Let not anyone species encroach upon the other's rights.'

The oldest visual image of the human fascination, love, and reverence for nature in India can be found in the 10,000 year-old cave paintings at Bhimbetka in Central India depicting birds, animals, and human beings living in harmony. The Indus Valley civilization provides evidence of human interest in wildlife, as seen in seals depicting images of rhino, elephant, bull, etc. Historically, conservation of nature and natural resources was an innate aspect of the Indian psyche and faith, reflected in religious practices, folklore, art and culture permeating every aspect of the daily lives of people. Scriptures and preaching that exhort reverence for nature and relate to conservation can be found in most of the religions that have flourished in the Indian subcontinent. Hinduism, Buddhism, Jainism, Christianity, Islam; and others place great emphasis on the values, beliefs, and attitudes that relate to the cross-cultural universality of respect for nature and the elements that constitute the universe. The concept of sinning against nature existed in various religious systems. Classical Indian myth is replete with similes of man in unison

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with the environment. Many of the rituals which to modern society may seem meaningless and superstitious were traditional strategies to preserve the intrinsic relationship between man and nature. The worship of trees, animals, forests, rivers, and the sun, and considering the earth itself as Mother Goddess, were part of the Indian tradition.

Sacred Groves

One of the finest examples of traditional practices in India based on religious faith which has made a profound contribution to nature conservation has been the maintenance of certain patches of land or forests as "sacred groves' dedicated to a deity or a village God, protected, and worshipped. These are found all over India, and abundantly along the Western Ghats, the west coast, and in several parts of Kerala, Karnataka, Tamil Nadu and Maharashtra. In Kerala there are hundreds of small jungles dedicated to snakes *(Sarpakavu, Sarpa* meaning snake, *kavu* meaning jungle). There are also Ayyappan *kavus* dedicated to Lord Ayyappa, the most famous of which, visited by millions of devotees every year, being the sacred hill of Sabarimala with an Ayyappan temple.

According to Madhav Gadgil (1985):

> Sacred groves ranged in extent from fifty hectares or more to a few hundred square metres. Where the network. of sacred groves has remained intact till recent times, as in the South Kanara district of the west coast, one can see that they formed island of climax vegetation at densities of 2 to 3 per. sq. km, ranging in size from a small clump to a hectare or more, and originally covering perhaps 5 per cent of the land area. This must have been a very effective way of preserving tropical biological diversity, for we are still discovering new species of plants which have disappeared from everywhere else, in these sacred groves.

In spite of the depletion of forests in many parts of India, some sacred groves still remain intact as oases in deserts, conserving rich biological diversity. The maintenance of sacred groves can thus he considered to be an outstanding example of a traditional practice that has contributed to forest conservation, albeit in a small measure. There are also examples of sacred ponds attached to temples in many parts of India. Some of these have been responsible for the protection of certain endangered species of turtles, crocodiles, and the rare fresh water sponge.

Sacred Plants and Animals

Many plants and animals have from historical times been considered sacred in India by various communities. The most outstanding examples are the peepal tree *(Ficus religiosa).* The banyan tree *(Ficus 'bengelensiss,* and Khejdi tree *(Prosopis cineraria),* and these have been traditionally revered and therefore never cut. There are a number of other trees and plants considered sacred and grown in temple premises and are protected in other localities. More than a hundred such species of trees/plants in India are considered sacred by various communities and religious faiths. These include the sandalwood tree, beetlenut, palm, *neem,* coconut palm, juniper, *champa,* lotus, *tulsi,* pepper, etc. Such

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traditional cultural attitudes, though based on religious faith, have made significant contribution in the protection and propagation of various species of trees and plants in India.

Many animals are considered sacred and worshipped by several Hindu and other communities, and have thus received protection for centuries. The peafowl, sacred to lord Karttikeya is never hunted, the blue rock pigeon is considered sacred to Saint Hazrat Shah lalal and is protected in the Bengal region. Even rodents are considered sacred and are allowed to breed in the famous temple of goddess Karnimata in Rajasthan. The tiger and the cobra, though greatly feared, are afforded protection on religious grounds. According to Asutosh Bhattacharya (1956):

> In the pre-Aryan society of India tiger worship was in vogue from the remotest past. The seal engraved with the image of Siva, lord of beasts, that has been discovered at Mohenjodaro has also, among other four principal beasts, the figure of a tiger engraved beside Siva. Siva, the god of the ancient non-Aryan race of India, is clad in a tigerskin and it is a tigerskin which is his seat. Probably the tiger was the most primitive vehicle of Siva. Later, when cow-worship started in society, Siva was made to ride on a bullock, but a tigerskin was preserved for his wearing cloth and seat. The legitimate conclusion form the association of this particular beast with the god Siva is that the tiger-worship of primitive society has subsequently got mixed with the Saiva cult. Another proof of the special vogue of tiger-worship in regions lying outside the pale of Aryan society in Northern India is that there is a community named Baghel Rajputs in Rajputana. Perhaps they are the descendants of some primitive community of tiger-worshippers. They worship tigers and never hunt them.

Snake worship has been an established cult among the Nairs of Kerala. Snake groves or *kavus* abounding in wild trees and creepers housing a cobra's head carved in granite were found near the homes of many Kerala Hindus. The celebrated Padmanabaswami temple in Thiruvanthapuram has Lord Vishnu reclining on a mighty serpent. Many other animals are also worshipped as they are considered vehicles of gods and goddesses.

Dealing with the status given to 'animals in India, Sadashiv Gorakshkar (1988) states:

> In Buddhist mythology, the *Jatakas* or the stories of the Buddha's previous life are replete with several incarnations of the Bodhisattvaas an animal. Among the Jains, eighteen of the twenty-four Tirthankaras have an animal as their cognizance. It is interesting to observe that the first, second and the eleventh Tirthankaras have a bull, an elephant and a rhinoceros as their cognizances. Their antiquity could be traced to the Indus valley period (c. 2500 -1750 BC). The famous Pasupati seal, for instance, shows a deity seated with a horned crown and surrounded by an elephant, a tiger, a rhino and a bull/buffalo. On the other hand, those of the first, second, third, and fourth, viz. the bull, elephant, horse and lion make their appearance on the Ashokan pillar capital at Sarnath in the third century BC.

All these accounts vividly show how the ancient culture and traditions of Indian society contributed to the conservation of natural ecosystems, and the plants and animals that inhabited these.

Nature in Indian Art and Scriptures

Indian painting, sculpture, architectural ornamentation, and the decorative arts is replete with themes from nature and wildlife reflecting love and reverence, and therefore the ethics of conservation. A wide range of images of forests, plants, and animals are to be found in Indian miniature paintings and sculpture. The theme of the Hindu God Krishna's life depicted in miniature paintings underlines an appreciation of ecological balance. He is shown persuading people to worship the mountain in order to ensure rainfall. Krishna swallowing the forest fire also signifies a concern for the protection of forests and wildlife.

Innumerable examples of the status given to plants and animals can also be seen in the traditional sculptural art of India. The concept of *vana devatas* (tree goddesses), vehicles of gods and goddesses, sacred trees, tree and animal worship, etc., are depicted in stone and metal sculptures independently, or as part of temples, palaces, and historical buildings. In literature and scriptures too there has been considerable depiction of the appreciation and love for nature:

"Mahakavi Kalidasa, a prominent poet of the ancient period (fourth century AD) visualized, a cloud as a messenger in his *Meghaduta* and went into raptures when describing various seasons in his *Ritusamhara.*" Such an involvement with nature is reflected even in the visual arts which excel in their minute depiction of nature.

Indian literature effectively mirrors the ethos of its deep and sympathetic understanding of animals through innumerable stories. Even amongst these one could pertinently mention are the *Hitopadesha,* the *Panchatantra* or the *Shuka-saptati* which abound in allegorical references to the animal world. The impact of the *Panchatantra* was so great that as early as the seventh century AD it was translated into Arabic under the title *Kalila-wa-Dimna* and has been very popular in the Arab and Persian world ever since. Though an interior form of life, animals have been endowed with ennobling qualities which provide lessons in morals relevant even to human beings.

Just as the appearance of animals in dreams or visions is considered to express energy, which has still not been differentiated or rationalized, identification of oneself with animals has been interpreted to represent integration of the unconscious with sources of life itself. Indian approach to the animal world has consistently demonstrated this appreciation throughout its evolving pattern of thought, and it is no wonder that Indian art, while reflecting the changing approach to physical representation of animal form, has retained the core of thought that it has moulded.

Other Specific Contributions to Conservation

Twenty-two centuries ago Emperor Ashoka decreed that it was a king's duty to protect wildlife and the trees of the forests. He got edicts inscribed on rocks and iron pillars throughout his kingdom, prohibiting the destruction of forests and the

killing of various species of animals. This historical evidence, surviving to this day, is the first recorded measure on conservation anywhere in the world. In more recent historical times, Mughal Emperor Babur's memoirs *(Baburnama)*, Guru Nanak's hymns on *'Baramasa'* (the seasons) depicting each month with a dominant bird image, and Emperor Jehangir's memoirs showing his keen interest in and study of wildlife provide fine illustrations of this Indian tradition.

The love for nature has been handed down the ages, becoming an integral part of the Indian psyche. Nowhere is this better exemplified than in the martyrdom of the Bishnois in Khejarli village in Rajasthan. In 1730 AD the then ruler of a native state had ordered the khejri *(Prosopis cineraria)* trees to be cut in order to bake lime for the construction of a fort. This sparked off a strong collective protest from the local Bishnoi community. 363 men and women, young and old, one after the other, placed their heads against the trees to prevent them being cut and were axed along with the trees. The ruler of the state was so moved by this sacrifice that he sought pardon from the people and issued an order that no green trees should in future be cut in the Bishnoi village. This happened over two centuries ago when the world had scarcely become conscious of ecological consequences of the reckless felling of trees. This legend is now celebrated by singers on stage and in the streets during the Tree Festival.

This long tradition and belief in the conservation of nature is also vividly alive in contemporary times. One of the most successful conservation movements in India today is the Chipko movement spearheaded by the womenfolk of Gopeswar village in Garhwal in the Himalaya. Commercial felling of trees was effectively stopped by them by hugging the trees when lumbermen arrived to cut them. This simple yet effective action eventually saved 12,000 sq.km. of a sensitive water catchment area. There was a similar Apiko movement in the southern state of Karnataka.

Environment and Development

India is no exception to the global phenomenon of environmental degradation brought about by developmental activities. Rapid industrialization, growing urbanization, intensive cultivation, and other developmental activities, coupled with increasing biotic pressure has had a very adverse impact on India's environment. The major areas of environmental concern today include, (i) deforestation, (ii) degradation of land resources, (iii) pollution of air and water, (iv) threat to natural living resources - wildlife, fisheries, etc., and (v) problems associated with urbanization - slums, sanitation and pollution.

Human and animal pressures have led to considerable deforestation. Deforestation leads to soil erosion and sedimentation that shortens the economic life of reservoirs, hydroelectric facilities, and irrigation systems. The problem of water and air pollution is assuming serious proportions in various parts of the country. With eighty per cent of industrial production confined to ten cities, atmospheric pollution is concentrated principally in the major cities and industrial

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towns. Apart from industries, the density of traffic is also contributing substantially to air pollution.

Habitat destruction has endangered the survival of a number of plants and animals.

Two species of mammals - the Indian cheetah and the Lesser Indian rhinoceros, and two species of birds – the Pink headed duck and the Mountain quail – have become extinct during twentieth century alone. Eighty-one species of mammals, 38 species of birds, and 18 species of amphibians and reptiles are now listed as 'rare' and 'threatened'. Among these are the tiger, leopard, Asiatic elephant, and all- the three species of the Indian crocodile. About 1500 species of plants are on the endangered list.

India has often been described as a rich land with poor people. Its average annual precipitation, the second highest in the world, next only to South America, its perpetual sunshine, and its other resources (natural and human) place it among the potentially rich nations. History, however, decreed otherwise and it found itself in 1947, at the time of Independence, among the poorest with "a majority of its people suffering from hunger, ignorance, and disease, and with little infrastructure for irrigation, power, transport, communication or industry. Only 25 per cent of its men and 7 per cent of its women knew how to read and write. The founding fathers of the nation led by Mahatma Gandhi and Jawaharlal Nehru realized that political independence would have no meaning unless it enabled them to quickly release themselves from the morass of poverty. Thus began, in the words of Indira Gandhi, 'an enterprise unparalleled in human history – the provision of basic needs to one-sixth of mankind within the span of one or two generations'.

It was in the early seventies that, along with the rest of the countries of the world, India became conscious of another disquieting trend. The same efforts that had helped to bring people above the poverty line also put greater pressure on the natural resources of the country. The vast majority of our people are directly dependent on the country's natural resources for their basic needs of food, fuel, shelter, and fodder for their cattle.

While the annual per capita income in India has been rising over the years, about 40 per cent of the people are still below the poverty line. Environmental degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus the challenge of poverty and the challenge of environmental degradation are not two different challenges, but two facets of a single challenge. In a developing country attempting to achieve rapid economic growth, there are often tensions between the claims of environmental protection and those of development. That environmental conservation cannot be isolated from the general issues of development and must be viewed as an integral part of it, and an essential prerequisite for sustainable development, is being increasingly understood today. Conscious efforts are now being made to integrate environmental concerns into policies and programmes relating to economic development. It is at

this juncture that we should look back upon our rich tradition of living in harmony with nature, which over the years have been overshadowed by the Western utilitarian approach to scientific and technological developments.

Madhav Gadgil and Romila Thapar (1990) focus our attention to our traditional relationship with nature when they say:

> India obviously needs a new strategy of resource use and a new common belief system to hold the society together and put this strategy into operation. The present strategy of resource-use intensification, leading to increasing levels of outflows from the countryside to the urban-industrial sector, which is heavily subsidized by the state, and from the country as a whole to the developed world, and the belief system centred on development and national prestige, which has replaced the unifying theme of a national struggle against the British, have proved inadequate. The new strategy has to be grounded in efficient, sustainable use of resources and supported by a belief system based on respect for the natural endowments of the country. There are welcome signs that such a strategy and such a belief system are beginning to emerge, although not enough has happened in terms of concrete action. What does ultimately happen will depend critically on how far society recognizes the real power of those whose well-being is organically linked to the health of the resource base of the country the peasants, the tribal peoples and the nomads.

Check Your Progress

1. What evidences of human interest in wildlife does the Indus Valley civilization provide?
2. Name the major areas of environmental concern today.
3. What is the adverse effect of soil erosion and sedimentation?
4. Which factors place India among the potentially rich nations?

4.3 COLONIAL ENVIRONMENT POLICY

In 1600, British arrived in India in the form of East India Company with the mission of trading goods from India. But, after seeing the immense amount of natural resources and plunders of opportunity to exploit the resources present here, they changed their game plan and started applying coercion so as to complete their aim of exploiting natural resources in India. At the time when British arrived in India, India was divided into several princely states ruled by different rulers. It was quite an easy task for the British to establish itself gradually and astutely. They very cleverly implemented the policy of Divide and Rule in India and took advantage of the diversity on the basis of different rulers as well as due to multiplicity of religion in the country. The early days of British rule in India were days of plunder of natural resources. They started exploiting the rich resources present in India by employing the policy of imperialism.

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By around 1860, Britain had emerged as the world leader in deforestation, devastating its own woods and the forests in Ireland, South Africa and the northeastern United States to draw timber for shipbuilding, iron-smelting and farming. Occasionally the British would destroy the forests to symbolize their political victory. Thus, the early nineteenth century, and following its defeat of the Marathas, the East India Company razed to the ground teak plantation in Ratnagiri nurtured and grown by the legendary Maratha Admiral Kanhoji Angre. There was a total indifference to the needs of the forest conservancy. They caused a fierce onslaught on Indian Forests. The onslaught on the forests was primarily because of the increasing demand for military purposes, for British navy, for local construction (such as roads and railways), supply of teak and sandalwood for export trade an extension of agriculture in order to supplement revenue.

The British government started taking control of the forest region in the year 1806 when a commission was appointed to enquire into the availability of teak in Malabar and Travancore by way of appointment of Conservator of Forest. This move failed to conserve forest as the appointed conservator plundered the forest wealth instead of conserving it. Consequently, the post of conservator of forest was abolished in the year 1823.

Their early treatment of the Indian forest also reinforces the claim that destructive energy of the British race all over the world was rapidly converting forest into desert. Until the later decades of nineteenth century, the British Raj carried out an immense onslaught on the subcontinent's forest. With the Oaks forest vanishing in England, a permanent supply of durable timber was required for the British Navy because the safety and defense of the British Empire depended primarily on its navy. In the period of fierce competition between the colonial powers, Indian teak, the most durable of shipbuilding, saved British during a war with Napoleon and the later maritime expansion. To tap the likely sources supply, search parties were sent to teak forests of India's west coast. Ships were built in the dockyards in the Surat and the Malabar Coast, as well as in England by importing teak from India.

The revenue orientation of colonial land policy also worked towards the denudation of forests. As their removal added to the class of land assessed for revenue, forests were considered as an obstruction to agriculture and consequently a bar to the prosperity of the British Empire. The dominant thrust of agrarian policy was to extend cultivation and the watchword of the time was to destroy the forest with this end in view.

This process greatly intensified in the early years of the building of the railways network after about 1853. While great chunks of forests were destroyed to meet the demand for railway sleepers, no supervision was exercised over the felling operation in which a large number of trees were felled and lay rotting on the road. The sub-Himalayan forests of Garhwal and Kumaon, for example were all felled in even to desolation and thousands of trees were felled which were never removed, nor was their removal possible.

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As early as 1805, the British government requested the British East India Company, which already controlled large parts of the coastal regions, to investigate the feasibility of harvesting Malabar teak in Madras to meet the needs of British shipbuilding during the Napoleonic war. Although the East India Company was a private trading company commissioned in 1600, in India it functioned as a state entity, enjoying a monopoly of trade in the areas it ruled. Acting at the direction of the British parliament, it shared authority in India with government officials. The company appointed a former police officer, Captain Watson, as India's first conservator of forests in 1806. Watson's two-pronged plan involved placing a tax on teak in order to simultaneously slow its harvest by private interests and raise money for the government, and then purchasing the teak from the private dealers. Together, these measures would guard against over-exploitation and ensure a steady supply of teak. On 3 August 1855, Lord Dalhousie, the governor general of India, reversed previous laissez-faire policy to establish the India Forest Department and annex large areas of sparsely populated lands in India. These lands were declared protected areas and staffed by foresters, fireguards, rangers, and administrators. Over the next decades, forestry in India became an international profession with global specialists ruling an empire of trees and grasslands.

The new environmental policies served in turn to support British imperialism in India. Unlike the conservative French and English royal forests reserved for hunting by the privileged elite, or the later American concept of total protection in national parks, the new colonial environmentalism was intended to generate income for the imperial British state through strict control of India's natural resources. Lord Dalhousie's new forest policies greatly expanded British authority over the land and people of India, a colonial empire that the British had procured piecemeal over the course of several centuries of mercantile and military exploitation. Thus, environmentalism and imperialism have a shared past, and the newly protected forests marked a symbiotic alliance of environmental concern with expansion of state power in India.

After Napoleon's defeat at Waterloo in 1815, however, the navy had less need of teak, and a new governor of Madras, Thomas Munro, felt that the timber royalty unnecessarily raised the opposition of Indian princes who objected to the tax placed on forests under their authority. Munro also felt pressure from Indian merchants who objected strenuously to a tax that cut severely into their profits and from peasants who saw traditional access to the forest sharply curtailed. The new governor rescinded the teak regulations, abolished Captain Watson's position, and allowed the free market to operate as it had before Lord Dalhousie's tenure as governor-general from 1848 to 1856 saw the acquisition of territory and implementation of administrative reforms for which posterity dubbed Dalhousie "the great Proconsul." Dalhousie's support for conservation was unapologetically imperialist. Upon reaching the capital at Calcutta for his inauguration in 1848, he proclaimed, "we are Lords Paramount of India, and our policy is to acquire as direct a dominion over the territories in possession of the native princes, as we

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already hold over the other half of India." The British government in India made it clear that "all the forests are the property of Government, and no general permission to cut timber therein will be granted to anyone."

The second half of the 19th century marked the beginning of an organized forest management in India with some administrative steps taken to conserve forest; the formulation of forest policy and the legislations to implement the policy decision. The systematic management of forest resources began with the appointment of the First Inspector General of Forest in 1964. Dietrich Brandis was the first Inspector General of India. Lord Canning appointed Dietrich Brandis as the first inspector general of the India-wide Indian Forest Department, a post he held from 1864 to 1883.

The immediate task of the forest department was under the supervision of Inspector General was that of exploration of resources, demarcation of reserves, protection of the forest from fire and assessment of the growing stock in valuable reserve by sample enumeration and prescription of yields which could be sustained. The objective of management of forest thus changed from obtaining of timber for various purposes to protecting and improving forests and treating them as a biological growing entity. Forest conservators had already been appointed in Bombay (1847), Madras (1856), and the United Burma Provinces (1857); Brandis in turn appointed forest conservators to the Northwestern Provinces and Central Provinces in 1860, Oudh in 1861, Punjab in 1864, Coorg and Bengal in 1864, Assam in 1868, and Berar in 1868. By the end of 1868, the Forest Department had administrators in every province of the subcontinent. In 1871, the Forest Department was placed under the newly established Department of Revenue and Agriculture, itself under the umbrella of the Home Department. Brandis was followed by Wilhelm Schlich (1883-88), Berthold Ribbentrop (1888-1900), and E. P. Stebbings (1900-17).

The first step of the British Government to assess state monopoly right over the forest was the enactment the Forest Act, 1865. The act was revised after about thirteen years later in 1878 and extended to most of the territories under the British rule. It also expanded the powers of the state by providing for reserved forest, which were closed to the people and by empowering the forest administration to impose penalties for any transgression of the provision of the Act. Yet the latter act was passed only after a prolonged and bitter debate within the protagonist of the earlier debate put forth arguments strikingly similar to those advanced by participants in the contemporary debate about the environment of India.

Hurriedly drafted, the 1865 act was passed to facilitate the acquisition of those forest areas that were earmarked for railway supplies. It merely sought to establish the claims of the state to the forests in immediately required, subject to the proviso that existing rights would not be abridged. Almost immediately, the search commenced for a more stringent and inclusive piece of legislation. A preliminary draft, prepared by Brandis in 1969, was circulated among the various

presidencies. A conference of forest officers, convened in 1874, then went into defects of the 1865 act and the details of the new one.

The British Government declared its first Forest Policy by a resolution on the 19th October 1884. The policy statement had the following objectives:

1. Promoting the general well-being of the people in the country
2. Preserving climatic and physical condition in the country
3. Fulfilling the need of the people

The policy also suggested a rough functional classification of forest into the following four categories:

1. Forests, the preservation of which was essential for climatic and physical grounds;
2. Forests which offered a supply a valuable timber for commercial purposes;
3. Minor forest which produced only the inferior sort of timber; and
4. Pastures, which were forest only in name.

To implement the Forest policy of 1884, the Forest act of 1927 was enacted. Till 1935, the government of India enacted the Forest Act. In 1935, the British Parliament through the Government of India created provincial legislature and the subject of the forest as included in the provincial legislature list. Thereafter, several provinces made their own laws to regulate forest. Most of these laws were within the framework laid down in the 1927 Act. The British all along their reign in India formed many other Acts from time to time.

Main Acts in the field of Environment in the British Era Acts controlling Water Pollution are as follows:

- The Shore Nuisance (Bombay and Kolaba) Act, 1853
- The Orient Gas Company Act, 1857
- Indian Penal Code, 1860
- The Serais Act, 1867
- The North India Canal and Drainage Act, 1873
- The Obstruction in Fairways Act, 1881
- The Indian Easement Act, 1882
- The Indian Fisheries Act, 1897
- The Indian Ports Act, 1908
- The Indian Steam Vessels Act, 1917
- The Poison Act, 1919
- The Indian Forest Act, 1927

The Shore Nuisance (Bombay and Kolaba) Act, 1853

This is the earliest Act on the statue book concerning control of water pollution in India. It was the first act in the field of Environment protection in India, which was enacted by the British for the British India. This act was passed so as to regulate the waste materials discharged in the coastal area of Bombay (Now Mumbai) and Colaba area, from various industries functioning in these areas.

Oriental Gas Company Act, 1857

This law imposed restrictions on fouling of water by the Oriental Gas Company. The Oriental Gas Company provided fine of Rs. 1000, for fouling water and for the subsequent continuation of the offence, Rs. 500 per day. Oriental Gas Company (OGC) Act was among the first act in the field of water pollution.

Indian Penal Code, 1860

As regards to water pollution, Indian Penal Code says that whoever voluntarily corrupts or fouls the water of any public spring or reservoir, so as to make it less fit for the purpose for which it is ordinarily used, shall be punished with simple or rigorous imprisonment for a term exceeding to three months or fine of five hundred rupees or both. The definition is confined to a voluntary act and acts committed without any knowledge or accidentally would not be covered under the present law. Moreover, it has limited operation to the water of public spring or reservoir. Further, looking to the gravity of the offence it attracts only minor punishment. It is surprising to know that in spite of the fact that this provision was incorporated to protect the public health, the cast ridden society wanted to enforce this provision against the lower cast person taking water from a public cistern but the Bombay High Court did not allow the above interpretation (R v Bhagi 2 Bom LR 1078) . Chapter 14th of the Indian Penal Code (IPC) is for Public Nuisance from section 268 to 291.

The Serais Act, 1867

The Act enjoined upon a keeper of Serai or an inn to keep a certain quality of water fit for consumption by "persons and use of it by the animals" to the satisfaction of the District magistrate or his nominees. Failure for maintaining the standard entailed a liability of rupees twenty. It is to be understood that the amount twenty rupees was a very big amount at that time and therefore should not be compared to the value of twenty rupees prevailing now in the country.

The North India Canal and Drainage Act, 1873

Certain offences have been listed under the Act contained in Section 70. It was to regulate the way canals for the purpose of irrigation as well as to discharge the effluents from various industries as well as drainage system is to be controlled.

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Obstruction in Fairways Act, 1881

Section 8 of the Act empowered the Central Government to make Rules to regulate or prohibit the throwing of rubbish in any fairway leading to a port causing or likely to give rise to a bank or shoal.

Indian Easements Act, 1882

It protected riparian owners against unreasonable pollution by upstream officer. Illustrations (f), (h) and (j) of Section 7 of the Act deal with pollution of waters. Section 28(d) of the Easement Act, 1882 on the one hand allowed a prescriptive right to pollute the water but it was not an absolute right. The illustrations (f), (g), and (j) of this Section, limited this prescriptive right not to unreasonably pollute or cause material injury to other.

The Indian Fisheries Act, 1897

The Indian Fisheries Act, 1897 contains seven sections. This act penalized the killing of fish by poisoning water and by using explosive. Section 5 of the Act prohibits destruction of fish by poisoning waters.

Indian Ports Act, 1908

The Indian Ports Act, 1908, has regulated water pollution caused by the use of oil or discharging of oil in the port waters.

The Indian Forest Act, 1927

This act was very comprehensive and contained all the major provisions of the earlier act and amendments made thereto including those relating to the duty on timber. The Act of 1927 also embodied land-using policy whereby the British could acquire all forestland, village forest and other Common Property Resources. Section 26(i) of the Act makes it punishable if any person, who, in contravention of the rules made by the State Government, poisons water of a forest area. The State Government has been empowered under Section 32(f) to make rules relating to poisoning of water in forests. This act is still in force, together with several amendments made by the State Governments.

Acts for the Protection of the Indian Environment

- The Orient Gas Company Act, 1857
- The Serais Act, 1857
- The Northern India Canal and Drainage Act, 1873
- The Obstruction in Airways Act, 1881
- The Indian Fisheries Act, 1897
- The Indian Ports Act, 1901
- The Bengal Smoke Nuisance Act, 1905

- The Explosives Act, 1908
- The Bombay Smoke Nuisance Act, 1912
- The Inland Stream Vessel Act, 1917
- The Mysore Destructive Insects & Pests Act, 1917
- The Poison Act, 1919
- The Andhra Pradesh Agricultural, Pest & Diseases Act, 1919
- The Indian Boilers Act, 1923
- The Workmen's Compensation Act, 1923
- The Indian Forest Act, 1927
- The Motor Vehicles Act, 1939
- The Bihar Wastelands (Reclamation, Cultivation & Improvement) Act, 1946.

Air Pollution Acts

- Indian Penal Code, 1860
- The Indian Boilers Act, 1923
- Motor Vehicle Act, 1939 (Repealed by Act No.59 of 1988)
- The Poison Act, 1919

Municipality Laws

- Uttar Pradesh Municipality Laws, 1916
- Bihar and Orissa Municipality Laws, 1922

Both of these laws were amongst the earliest laws for regulating the environment conditions in the cities by the help of municipality laws.

Wildlife Protection Act

- Forest act of Madras 1873
- Elephant Preservation Act, 1879
- World Birds Protection Act, 1887
- World Birds and Animal Protection Act, 1912
- Hailey National Park Act,1936 (Now Called Corbett National Park)

In the field of wildlife protection, the first wildlife statute was enacted in Madras (Chennai) for the protection of wild elephants. The law introduced a general prohibition on destruction of wild elephants and imposed penalty on those who violated the embargo. The first effort by the Central Government came after six years later by the passing of the Elephant Preservation Act in 1879. In 1887, central government enacted the Wild Birds Protection Act prohibiting the possession or sale of wild birds recently killed or taken during the notified breeding season. In 1912, the Central Government enacted a broader Wild Life and Animal Protection

Act. Extending to most of the British India, this law specified a closed hunting season and regulated the hunting of designated species through licenses. Indeed, all the statutes related primarily to the regulation of hunting and did not regulate trade in wildlife and wildlife products- both major factors in the decline of Indian Wildlife. As a consequence, wildlife depredation continued and many species became extinct.

The first comprehensive law for the protection of wildlife and its habitat was perhaps the Hailey National Park Act of 1936, which established the Hailey (now Corbett) National park in Uttar Pradesh.

Miscellaneous

- The Indian Fisheries Act, 1897
- The Indian Forest Act, 1927
- Criminal Procedure Code, 1893

Criminal Procedure Code, 1893

Criminal Procedure Code, 1893 was one of the major acts, which provided some of the very strict punishments for the environmental offences under the criminal law. Sections 133 to 144 in the Chapter XII of the Criminal Procedure under the heading Public Nuisance provided for the punishment under criminal procedure for the commission of any nuisance, which affected the public at large. The environmental degradation was also included in it as any degradation of the environment is automatically supposed to be affecting the public at large.

Check Your Progress

5. Why did the British change their plan of doing trade to exploiting natural resources in India?
6. What was Watson's two-pronged plan as the first conservator of forests in 1806?

4.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The Indus Valley civilization provides evidence of human interest in wildlife, as seen in seals depicting images of rhino, elephant, bull, etc.
2. The major areas of environmental concern today include, (i) deforestation, (ii) degradation of land resources, (iii) pollution of air and water, (iv) threat to natural living resources - wildlife, fisheries, etc., and (v) problems associated with urbanization - slums, sanitation and pollution.
3. Deforestation leads to soil erosion and sedimentation that shortens the economic life of reservoirs, hydroelectric facilities, and irrigation systems.

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4. India's average annual precipitation, the second highest in the world, next only to South America, its perpetual sunshine, and its other resources (natural and human) place it among the potentially rich nations.
5. After seeing the immense amount of natural resources and plunders of opportunity to exploit the resources present here, the British changed their game plan and started applying coercion so as to complete their aim of exploiting natural resources in India.
6. Watson's two-pronged plan involved placing a tax on teak in order to simultaneously slow its harvest by private interests and raise money for the government, and then purchasing the teak from the private dealers.

4.5 SUMMARY

- Living in harmony with Nature has been an integral part of Indian culture. This has been abundantly reflected in a variety of traditional practices, religious beliefs, rituals, folklore, arts and crafts, and in the daily lives of the Indian people from time immemorial.
- Many ancient cultures tell us how communities lived in harmony with nature, with a tradition of reverence for the elements that constitute ecosystems, drawing their sustenance from natural resources and at the same time protecting the environment that sustains them.
- The worship of Mother Earth is a universal phenomenon in many indigenous cultures.
- Scriptures and preaching that exhort reverence for nature and relate to conservation can be found in most of the religions that have flourished in the Indian subcontinent. Hinduism, Buddhism, Jainism, Christianity, Islam; and others place great emphasis on the values, beliefs, and attitudes that relate to the cross-cultural universality of respect for nature and the elements that constitute the universe.
- One of the finest examples of traditional practices in India based on religious faith which has made a profound contribution to nature conservation has been the maintenance of certain patches of land or forests as "sacred groves' dedicated to a deity or a village God, protected, and worshipped.
- The maintenance of sacred groves can thus he considered to be an outstanding example of a traditional practice that has contributed to forest conservation, albeit in a small measure.
- Many plants and animals have from historical times been considered sacred in India by various communities.
- Indian painting, sculpture, architectural ornamentation, and the decorative arts is replete with themes from nature and wildlife reflecting love and reverence, and therefore the ethics of conservation. A wide range of images

of forests, plants, and animals are to be found in Indian miniature paintings and sculpture.

- The major areas of environmental concern today include, (i) deforestation, (ii) degradation of land resources, (iii) pollution of air and water, (iv) threat to natural living resources - wildlife, fisheries, etc., and (v) problems associated with urbanization - slums, sanitation and pollution.
- India has often been described as a rich land with poor people. Its average annual precipitation, the second highest in the world, next only to South America, its perpetual sunshine, and its other resources (natural and human) place it among the potentially rich nations.
- By around 1860, Britain had emerged as the world leader in deforestation, devastating its own woods and the forests in Ireland, South Africa and the northeastern United States to draw timber for shipbuilding, iron-smelting and farming. Occasionally the British would destroy the forests to symbolize their political victory.
- The revenue orientation of colonial land policy also worked towards the denudation of forests.
- Acting at the direction of the British parliament, the Company shared authority in India with government officials. It appointed a former police officer, Captain Watson, as India's first conservator of forests in 1806. Watson's two-pronged plan involved placing a tax on teak in order to simultaneously slow its harvest by private interests and raise money for the government, and then purchasing the teak from the private dealers.
- Lord Dalhousie's new forest policies greatly expanded British authority over the land and people of India, a colonial empire that the British had procured piecemeal over the course of several centuries of mercantile and military exploitation.
- In 1871, the Forest Department was placed under the newly established Department of Revenue and Agriculture, itself under the umbrella of the Home Department.
- The first step of the British Government to assess state monopoly right over the forest was the enactment the Forest Act, 1865.
- The Shore Nuisance (Bombay and Kolaba) Act, 1853 is the earliest Act on the statue book concerning control of water pollution in India. It was the first act in the field of Environment protection in India, which was enacted by the British for the British India.
- In the field of wildlife protection, the first wildlife statute was enacted in Madras (Chennai) for the protection of wild elephants. The law introduced a general prohibition on destruction of wild elephants and imposed penalty on those who violated the embargo.

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- The Indian Forest Act, 1927 was very comprehensive and contained all the major provisions of the earlier act and amendments made thereto including those relating to the duty on timber. The Act of 1927 also embodied land-using policy whereby the British could acquire all forestland, village forest and other Common Property Resources.

4.6 KEY WORDS

- **Culture:** It refers to the customs, arts, social institutions, and achievements of a particular nation, people, or other social group.
- **Worship:** It refers to the acts or rites that make up a formal expression of reverence for a deity; a religious ceremony or ceremonies.
- **Groves:** It refers to a small wood, orchard, or group of trees.
- **Scripture:** It is the sacred writings of a religion.
- **Environmental degradation:** It is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution.
- **Environment policy:** It is the commitment of an organization or government to the laws, regulations, and other policy mechanisms concerning environmental issues.

4.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are sacred groves? Give examples.
2. State the importance of plants and trees in Indian tradition?
3. How did the new environmental policies support British imperialism in India?
4. Why was Dalhousie ‘the great Proconsul’?
5. What were the objectives of the first Forest policy declared by the British government in1884?

Long-Answer Questions

1. Describe the accounts showing the contribution of ancient culture and traditions of Indian society to the conservation of natural ecosystems.
2. How is the importance of nature conservation depicted in Indian arts and scriptures? Explain.

3. 'The challenge of poverty and the challenge of environmental degradation are not two different challenges, but two facets of a single challenge.' Elucidate the statement.
4. How did the forestry in India become an international profession with global specialists ruling an empire of trees and grasslands during 1860s? Explain.
5. Comment on the statement, 'Environmentalism and imperialism have a shared past.'

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4.8 FURTHER READINGS

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BLOCK II
FOREST AND ITS IMPORTANCE

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UNIT 5 MANAGEMENT OF FORESTS

Structure

5.0 INTRODUCTION

The aim of forestland management is to make sure that the government has forestland utilization under its control, as well as to ensure that the lands allocated for forest industry uses are actually applied for forestry purposes to protect our natural resources from exploitation. According to the report on sustainable land management (SLM) by the UNCCD Science-Policy Interface (SPI), forest and woodland areas continue to decline worldwide. According to the FAO 2015 Global Forest Resources Assessment, between 2000 and 2010, an estimated 13 million hectares of forest was lost to deforestation per year. Drivers of deforestation include conversion to other land uses, such as agriculture, extractive activities, and infrastructure. Other drivers, such as fire, windstorms, pests, and diseases, are also significant contributors of forest loss. Forest policy of a country specifies certain broad principles for the use of a nation's forest resources. Earlier the forest policies in India tended to regard timber production as the primary function of the forests. However, in today's context, a multiplicity of interests competes for forest outputs and correspondingly forest policies have become increasingly responsive to emerging varieties of demands. In this unit, we will study in detail about the forest land management and the resistance system to it.

5.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the system of forest land management in India

- Explain the meaning of protected areas and various Acts relating to forest conservation
- Discuss the meaning of resistance and resilience in context of forest management

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5.2 FOREST LAND AND FOREST MANAGEMENT

Indian forest policies have alienated people from the forests, thereby, exacerbating the rates of deforestation. Post-independence forest policies gave rise to an expansion in agricultural production, met industrial demand for raw materials, and tightened control of forest lands through restricted access to forests and forest products. Protection policies increased the hardships of vulnerable social groups by denying them access to forests. While the state took responsibility for managing forest resources, it did not have the commensurate resources to effectively manage and police the forests from traditional users. Before state intervention, forests were managed as communal property; the crucial role of forests in the economic subsistence of individuals, families and community was the basis for managing them as communal resources. A failure to recognize community control of forests led to a collapse in institutional norms that were instrumental in protecting and managing forest resources for local use. A shift in property rights to the state steadily undermined the rights of tribals to use and extract forest resources.

Involvement of rural communities living close to forests in protection and management of forest resources is enshrined in the National Forest Policy 1988.Translation of policy found expression in the resolution of Government of India, Ministry of Environment and Forests issued in June 1990.It envisaged that in lieu of the participation, the local communities will be entitled to sharing of usufructs in a manner specified by the concerned State Forest Departments. This led to the initiation of Joint Forest Management (JFM) programme. Importance of the programme is evident from the fact that the Government of India has constituted a "JFM Network" with the Inspector General of Forests, Government of India as the Chairman.

The objectives of the network are as follows:

(i) To act as a regular mechanism of consultation between various agencies engaged in JFM work in the country and

(ii) To obtain constant feedback from various stakeholders on the JFM programme for proper policy formulation and suitable direction to States.

World leaders adopted the Millennium Declaration at the Millennium Summit in September 2000. The proportion of land area covered by forest globally is one of the indicators for the seventh MDG, i.e., to ensure environmental sustainability. In addition to quantitative, time-bound targets, the Millennium Declaration calls for other actions, including intensified efforts for "the management, conservation

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and sustainable development of all types of forests", an international commitment to sustainable forest management made in 1992 at the United Nations Conference on Environment and Development (UNCED) and embodied in the Forest Principles and Chapter 11 of Agenda 21. Subsequent intergovernmental deliberations to promote progress towards sustainable forest management took place in the Intergovernmental Panel on Forests (IPF) and Intergovernmental Forum on Forests (IFF) from 1995 to 2000, and continue in the United Nations Forum on Forests (UNFF) as well as at other places. Post 2015, the sustainable development goals have been agreed upon. The sustainable development goals specifically the SDG 15 aims to 'protect, restore and promote' use of terrestrial ecosystems as well as sustainably manage forests among other things.

Joint Forest Management and Forest Policy in Inida

Forest-based poverty reduction efforts tend to be linked to other land uses and should form a part of rural development strategies. Conversely, the potential for forests and trees outside forests to contribute to environmental sustainability cannot be fully realized without intersectoral cooperation and coordination. Intersectoral coordination, although difficult and time consuming, is necessary for sound decisions on land use and resource allocation, particularly when there are trade-offs between national development goals.

National Forest Policy in India treats forests as environmental and social resource. With the initiative of assigning ownership of Non Timber forest Produce (NTFP) to the local communities including the grass root level democratic institution for enhancing their livelihood opportunities and also improving their income with the value addition.

India has shifted the approach of forest management from regulatory to participatory mode of management with the resolution promulgated in 1990. At present, more than 17 million forests are managed by almost 10,000 Joint Forest Management Committees with the benefit sharing mechanism. In addition, the Government of India is in process to frame legislation for the settlement of tenurial rights of the forest dwelling communities mainly tribal on forests. This would definitely help in reducing the poverty of forest dwelling communities.

The JFM resolution was circulated by Ministry of Environment and Forest in the year 1990 and 2000. JFM is a government resolution. A government resolution is a executive order or opinion of the legislature. A resolution does not have any legal backing.

JFM as the term indicates is the management of forest by more than one party. In India there are two parties: the government represented by the Forest Department and the people living in villages located within forest or on the fringes.

There are two major reasons behind introducing JFM: one that the government's management system was not succeeding in arresting growth of forest degradation and deforestation. Second a new management paradigm was evolving

in which the local people's participation was found to be an appropriate and promising tool in arresting forest degradation.

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However in pre-independent India the concept of JFM didn't exist. The first National Forest Policy was adopted in 1894. Following were the guidelines:

- Ensure maintenance of adequate forest cover
- Meet the needs of local people
- Collect maximum revenue after meeting the needs of the local people
- Give priority to permanent cultivation over forestry land

In post independent India there was a shift in policy. In1988, the new forest policy was adopted which covered all the sustainable management approaches. The new policy had a few unique features which were as follows:

- Maintenance of environmental stability and restoration of ecological balance, soil and water conservation
- Conservation of natural heritage and genetic resources
- Increasing productivity to meet the local needs then the national need
- Creating massive peoples participation movement to protect forest and tree cover and achieve the objective of reducing pressure on existing forests and meeting peoples need
- Deriving economic benefits must be subordinated to these principal aims

This initiated a process of reform at the local policy and operational level of forest management ensuring that the Forest Department developed close collaboration for protection and sustainable management of forests.

The aim was the involvement of village communities and voluntary agencies of degraded forest land.

Important guidelines were as follows:

- The program should be implemented under an arrangement between a voluntary agency or beneficiaries and the State Department.
- No ownership rights or lease should be given over the forest land.
- The beneficiaries should be entitled to share usufructs to the extent and subject to conditions prescribed by the State Government.
- Access to forest land products benefactors should be available only to benefactress who get organized into a village institution especially for forest regeneration and protection. This could be through a village panchayat or a Village Forest Committee.
- The beneficiaries should be given products like grass, lops and tops of branches and minor forest produce. If they successfully protect the forest they will be a portion from the sale proceeds when they mature.

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- Areas selected from the program should be free from claims from any person who is both a beneficiary under the scheme.
- The selected site should be worked in accordance of Working Scheme duly approved by the state government .Such a scheme may remain in operation for ten years and revised after that. The working scheme is prepared in consultation of with the beneficiaries
- It should ensure that there is no grazing at all on the forest land protected by the Village Forest Committee. Permission to cut and carry grass free of cost should be given so that stall feeding is promoted.
- No agriculture should be promoted on the forest land.
- Cutting of tress should not be permitted before they are ripe for harvesting. The Forest Department should not be permitted to cut to cut trees protected by the Village Forest Committee except in a manner prescribed in the working scheme. In case of emergency needs the village community should be taken into confidence.
- The Forest Department should closely supervise the work.

Such set-up, however suffered from certain flaws which are as follows:

- Bye- laws have not been formulated for the functioning of the JFMC though now most of the states have issued executive orders for the functioning of JFMC but these executive orders are not binding on JFMC. The aim was to decentralize the process and make JFMC.
- Minor Forest Produce (MFP) has not been defined neither by the State legislature nor by the Centre.
- Central and State/UT Governments have issued guidelines for the creation and functioning of JFMC but these guidelines are not in conformity with the provisions of the Constitution
- Through the Constitution (Seventy-third Amendment) Act, 1992 and Panchayat (Extension to the Scheduled Areas) Act, 1996 ownership rights over minor forest produce (MFP) have been given to Village Panchayats.
- The JFM resolution only provides 20% of share to be given the Joint Forest Management committees, while rest of the income would go to the Forest Department. There is an obvious unequal distribution of benefit sharing between the parties. These committees would have to protect the forest for ten years, and would only receive 20% of the share.
- The national resolution provides that at least 33% of the seats shall be reserved for women in the specified committees. However states like Rajasthan are not following this provision.

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The Beginning of Land Alienation

Introduction of the alien concept of private property began with the Permanent Settlement of the British in 1793 and the establishment of the 'Zamindari' system that conferred control over vast territories, including Adivasi territories, to designated feudal lords for the purpose of revenue collection by the British. This drastically commenced the forced restructuring of the relationship of Adivasis to their territories as well as the powe relationship between Adivasis and 'others'. The predominant external caste-based religion sanctioned and practiced a rigid and highly discriminatory hierarchical ordering with a strong cultural mooring.

After the transfer of power, the rulers of the Residency Areas signed the "Deed of Accession" on behalf of the ruled on exchange they were offered privy purse. No deed was however signed with most of the independent Adivasi states. They were assumed to have joined the Union. The government rode rough shod on independent Adivasi nations and they were merged with the Indian Union. This happened even by means of state violence as in the case of Adivasi uprising in the Nizam's State of Hyderabad and Nagalim.

The Constitution of India, which came into existence on 26 January 1950, prohibits discrimination on grounds of religion, race, caste, sex or place of birth (Article 15) and it provides the right to equality (Article 14), to freedom of religion (Articles 25-28) and to culture and education (Articles 29-30). STs are supposedly addressed by as many as 209 Articles and 2 special schedules of the Constitution - Articles and special schedules which are protective and paternalistic.

Article 341 and 342 provides for classification of Scheduled Castes (the untouchable lower castes) and STs, while Articles 330, 332 and 334 provides for reservation of seats in Parliament and Assemblies. For purposes of specific focus on the development of STs, the government has adopted a package of programmes, which is administered in specific geographical areas with considerable ST population, and it covers 69% of the tribal population.

Forest Laws in Relation to Tribal Land Conflict

The total forest cover in India is reported to be 765.21 thousand sq. km of which 71% are Adivasi areas. Out of this 416.52 and 223.30 thousand sq. kms. is categorised as reserved and protected forest respectively. About 23% of these are further declared as Wild Life Sanctuaries and National Parks which alone has displaced some half a million Adivasis. By the process of colonisation of the forests that began formally with the Forest Act of 1864 and finally the Indian Forest Act of 1927, the rights of Adivasis were reduced to mere privileges conferred by the state.

The Imperial Forest Department was formed in 1864. The first Act for the regulation of forests was passed in 1865. It empowered the government to declare any land covered with trees or brushwood as government forest and to make

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rules to manage them. The act was applicable only to the forests in control of the government and did not cover private forests. It made no provision regarding the rights of the users. Its primary function was to generate revenue by selling timber and forest produce. Since forests are deemed to be government property, Adivasis were barred from collecting forest produce.

According to the Indian Forest Act, 1927, the Government can constitute any forest land or waste land which is the property of Government or over which the Government has proprietary rights, a reserved forest, by issuing a notification to this effect. Commercial interests of the then British Government motivated it to declare more and more lands as reserved forests, without ascertaining the rights of the tribals and other forest dwellers.

After the enforcement of the Indian Forest Act in 1927, the government declared all lands not claimed by private individuals and agencies as forest lands and classified them into reserve, protected and village forests. To attract labour to work in forestry related activities, the governments gave lands to households for cultivation and also promised jobs. A number of forest villages were established. The lands allotted for cultivation were on a purely temporary basis and forest officials were to look after the administration of these villages.

After Independence, the inhabitants of forest villages realized that most villages lacked infrastructure facilities; they could not get loans for development of agriculture as they had no title over the land. Around 1980, the government decided to convert forest villages into revenue villages. This was done in many states. However, not all the forest villages have been converted into revenue villages. In some villages, land has been given on a 15 year lease to enable the holders to obtain loans from banks. Residents have agitated for the conversion of these villages into revenue villages.

Even after independence in 1947, during the process of amalgamation of princely states, the activity of consolidation of government forests continued. The State Governments / UT Administrations proclaimed the lands of ex-princely states and the zamindar-lands as Reserved Forests. However, no effective steps were taken to give an alternative accommodation to the tribal people residing in this area. Bar on accrual rights are imposed through section 5 of the Indian Forest Act.

The Act invites claims for settlement in the reserve forest area. This is provided from section 3 to section 20 of the IFA. These sections provide a complicated procedure which requires documentation in relation to ownership of the land, evidence, which would be impossible for an indigenous to produce in front of the Settlement Officer. Many tribal families today are regarded as "encroachers" on forest land (persons who are cultivating or residing on forest land without a legal right to be there).

In many cases, however, it would be more accurate to say that the 'forest' is encroaching on their traditional rights. There are a number of core issues that

are central to the resolution of forest based conflicts, and are integral to the question of encroachment.

Protected Areas

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About 4.5% of the total land in the country is covered under protected areas, classified into national parks, wildlife sanctuaries and protected areas. The Wildlife (Protection) Act of 1972 provided for the administration of these areas. The act places several restrictions on the residents of villages in these areas. Efforts are also being made to relocate these villages outside such areas. These efforts have met with stiff resistance from the residents and violent conflicts have taken place in many places. Under pressure from the World Bank and the environment protection fund agencies, the government has tightened the restrictions on the hunting of animals included in the list of wildlife species, as also a number of economic activities. Consequently, development projects in these areas have been shelved.

Throughout this, one needs to be acutely aware that there are huge forest encroachments by powerful vested interests which need to be dealt with strictly. Mechanisms will need to be put in place to ensure that powerful interests/ land mafias do not use poor people as a front to further their encroachments. In the past two decades even as the genuine forest dwellers have lived in the fear of eviction, mafias have continued to encroach forests and alienate tribal land. This has not only had severe ecological implications due to disturbance of forest and wildlife but also displaced tribals from their homes and livelihoods.

Forests Conservation Act

The 42nd Constitutional Amendment shifts forests from the “State List” to the “Concurrent List”. The FCA prohibits non-forest use of forest land without the government’s approval. It also advocates “sustainable forest management through participatory approach”, with “due regard to the traditional rights of the tribal people on forest land”. Further making the claim settlement process stringent and inflexible and thereby the settlement dispute continues for decade.

The 1990 guidelines on Tribal and Forest Interface expressly provides for speedy settlement of claims in relation to forest land, Regularization of Encroachments; Review of Disputed Claims over Forest Land; Regularization of Pattas & Leases; and Conversion of Forest Villages to Revenue Villages. These Guidelines were supposed to provide a framework to resolve the problem of settlement of rights of tribals and other forest dwellers on forest land. For instance, FP1 outlined procedures whereby state governments could apply to the Government of India for regularization of “pre-1980 encroachments”. As discussed below, however, these Guidelines have not been implemented.

On 5 February 2004, the MoEF issued new guidelines for “regularization of the rights of the tribals on the forest lands”, in continuation of the 1990 Guidelines. These “supplementary guidelines” request the State Governments to give legal

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recognition to “the traditional rights of the tribal population on forest lands”, and to submit proposals for conferring “heritable but inalienable rights over such lands” on “tribal dwellers who are in continuous occupation of such forest land at least since 31 December 1993”.

There are thousands of cases of local inhabitants claiming that they were in occupation of notified forestlands prior to initiation of forest settlements under the Indian Forest Act. There are a number of cases of pattas/leases/grants said to be issued under proper authority but which has now become contentious issues between different departments, particularly the Forest Department and the Revenue Department. The problem is compounded by the fact that in many cases there is no clear demarcation of forest lands. In fact most of the disputes and claims relating to use and access to forests have lingered on and evaded resolution in the past because of the failure to demarcate precisely the extent of the forest. All of these require remedies and an approach aimed at only evicting the forest-dwellers is worsening the situation, not remedying it.

There is a need to consciously distinguish between the authorised/ unauthorized occupation of forests by dwellers for bonafide consumption, and the use of forest resources from the large scale timber and fuel wood smuggling and intensive commercial exploitation of forest resources. In the former case the so-called encroachment is a local and subsistence-oriented activity, while in the latter case it is a widespread organized industry largely driven by the mafia. The approach of the law and policy to the two situations cannot be the same

The National Forest Policy was adopted in 1894. Following were the guidelines:

- Ensure maintenance of adequate forest cover
- Meet the needs of local people
- Collect maximum revenue after meeting the needs of the local people
- Give priority to permanent cultivation over forestry land

In post independent India there was a shift in policy. The National Forest Policy Resolution 1952 adopted by the government, emphasised that the forest policy should be based on paramount national needs. For the first time the resolution emphasized the ecological and social aspects of forest management, giving secondary importance to the needs of commerce, industry and revenue. The resolution did not call for any change in the forest law and remained only a pious declaration.

The National Forest Policy, 1988, has a separate section on ‘Tribal people and forests’ which states that: “having regard to the symbiotic relationship between the tribal people and forests, a primary task of all agencies responsible for forest management, including the forest development corporations should be to associate the tribal people closely in the protection, regeneration and development of forests as well as to provide gainful employment to people living in and around the forest.”

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The section on 'rights and concessions' has focussed on 'full protection' of the rights of tribals.

In 1988, the new forest policy was adopted which covered all the sustainable management approaches. The new policy had a few unique features which were as follows:

- Maintenance of environmental stability and restoration of ecological balance, soil and water conservation
- Conservation of natural heritage and genetic resources
- Increasing productivity to meet the local needs then the national need
- Creating massive peoples participation movement to protect forest and tree cover and achieve the objective of reducing pressure on existing forests and meeting peoples need
- Deriving economic benefits must be subordinated to these principal aims\

This initiated a process of reform at the local policy and operational level of forest management ensuring that the Forest Department developed close collaboration for protection and sustainable management of forests. While the resolution adopted a pro-tribal policy, the old Act of 1927 with all the subsequent amendments remained unchanged.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2007

The recently notified Act aims to compensate the "historical injustice" done to forest-dwelling tribes that were denied their traditional rights to forest lands and resources in the last couple of hundred years. In this period, the lands they had been dwelling on were declared "forest land" or "protected areas" for wildlife. The traditional conservation ethos and dependence of tribal societies on forest land were overlooked. The Act aims to reverse the alienation of tribes from their own habitat caused by past policies and laws.

The rights proposed to be accorded to Adivasis include pattas to forest lands occupied before 1980. This is not new; it has been a stated policy of the government for years now. A number of other rights are also to be granted: nistar (usufruct) or ownership rights to forest resources, grazing rights including seasonal ones of nomadic communities, habitation rights (for those classified as Primitive Tribal Groups), conversion of forest villages into revenue villages, and so on. No tribal person is to be evicted from currently occupied land until the process of determining rights is completed.

Under the Act:

- All rights are accompanied by responsibilities for forest protection;
- All right holders have the duty to conserve forests and wildlife, protect catchment areas, water sources, and ecologically sensitive areas, and inform the gram sabha of ecologically destructive activities;

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- Hunting is explicitly excluded from the list of forest rights;
- All rights are meant only for bona fide livelihood needs, not for exclusive commercial purposes;
- In no case would forest land beyond 2.5 hectares be allotted (only land under occupation prior to 1980 can be considered, no new forest lands would be allotted).

The MOEF is of the view, land settlement of the forest dwellers would increase the problem of encroachment to the already depleting forest cover in our country, poaching would be rampant.

Check Your Progress

1. What are the objective of the Joint Forest Management (JFM) network?
2. Which SDG aims to sustainable management of forests?

5.3 RESISTANCE SYSTEM TO FOREST MANAGEMENT

Increasingly, forest management goals include building or maintaining resistance to disturbances in the face of climate change. Although many descriptive definitions for resistance and resilience exist, to evaluate whether specific management activities (silviculture) are effective, prescriptive characterizations are necessary. Generally, resistance is characterized as the influence of structure and composition on disturbance, whereas resilience is characterized as the influence of disturbance on subsequent structure and composition.

In general, resistance is the ability of a community to remain unchanged when challenged by disturbances, and resilience is "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" as originally defined by Holling (1973). The terms resistance and resilience are used in a variety of ways, which are often ambiguous, qualitative, and seemingly independent of disturbance type. Furthermore, sometimes characterization of resistance focuses on the system and sometimes on the disturbance (e.g., the amount of disturbance necessary to change the system), as disturbance intensity has been shown to influence both resistance and resilience. Rarely is resilience characterized in the context of both the system and associated disturbances. Appropriately, it has been suggested that resilience be defined as resilience "of what, to what" at appropriate scales of space and time, something rarely done in contemporary literature. If management goals include building resistance and/or resilience to disturbances that potentially affect large areas, then their definitions should reflect whether the disturbance affects individual stands or entire landscapes. In some contexts, descriptive definitions of resistance and resilience may be useful, but to evaluate

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whether objectives are achieved in a silvicultural or operational context, they must be defined in measurable and consistent terms. Structure and composition of stands and landscapes are measurable and can be used in prescriptive characterizations of resistance and resilience to disturbance. Given the above definitions from the literature, we propose that it is appropriate to characterize stand resistance to disturbance as the influence of structure and composition on the severity of disturbance. Of course, many disturbances occur at the scale of many stands; consequently, landscape resistance is characterized as the influence of landscape structure and composition on the spread of disturbance.

In the US, a conceptual framework was introduced that explicitly differentiates resistance and resilience, denotes appropriate scales, and establishes the context for evaluation—structure and composition. We will take two different instances in the context of the US to understand the idea of resistance to forest management. Silvicultural utility of the framework is demonstrated by describing disturbance-specific, time-bound structural and compositional objectives for building resistance and resilience to two fundamentally different disturbances: wildfires and spruce beetle outbreaks. The conceptual framework revealed the crucial insight that attempts to build stand or landscape resistance to spruce beetle outbreaks will ultimately be unsuccessful. This frees the silviculturist to focus on realistic goals associated with building resilience to likely inevitable outbreaks.

Resistance and Resilience to Wildfire

Fires are a natural part of many forested systems, and their management is a topic of considerable interest. Recently, a strong case has been made for shifting the focus of wildland fire management in dry, mixed-conifer forests from suppression and control to the maintenance of fire-resilient forests capable of absorbing inevitable fires without fundamentally changing the system at the landscape scale. Because of the strong research focus on dry-site forests the following silvicultural approaches are not necessarily appropriate in other forest types such as coastal temperate or subalpine forests. Resistance is the influence of structure and composition on the severity of fire. To assess how stand or landscape resistance is achieved, specific structural and compositional attributes are evaluated with respect to their expected influence on fire behaviour. Evaluation criteria are based on predetermined thresholds of extreme fire behaviour, such as the mitigation of unwanted fire effects. Characterization of extreme fire weather typically quantifies temperatures, moistures, and wind speeds that are unusual but not unprecedented. Models and empirical observations provide compelling evidence that thinning to reduce canopy bulk density and eliminate ladder fuels, combined with surface fuel reduction, can result in dramatically altered fire behaviour. Whereas stand level treatments for resistance are demonstrably effective in influencing the behaviour of fire within treated stands, they are costly, and the effects are short-term and small-scale. Furthermore, most wildfires occur over large areas composed of many stands, making characterization of resistance in the context of the landscape important.

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Landscape resistance is characterized as the influence of multistand structure and composition on the spread of fire. A highly resistant landscape could in principle be composed entirely of highly resistant stands; however, as a management strategy this is unrealistic in terms of scale and in particular over the long-term. In the absence of continued treatment, extreme fire behaviour is inevitable. Ultimately, fuels treatments are not intended to eliminate fire but to modify fire behaviour, such as reducing potential fire behaviour from crown fire to surface fire to increase fire suppression effectiveness and lessen impacts on the overstory without compromising other ecological goods and services. This could be accomplished by using strategically placed area treatments (SPLATs). SPLATs can, at least in theory, slow fire rate of spread by as much as 60% with as little as 20% of the area treated, compared with spread on untreated landscapes. The strategic placement of fuel treatments across the landscape increases the likelihood that a large proportion of the forest, substantially greater than the proportion actually treated, will be resistant to high-severity wildfire. Stand resilience is characterized as the influence of fire on subsequent mortality and species composition relative to those that are desired after a fire. Stand resilience to wildfire could be defined as low mortality in the overstory as a result of a fire. It is different from stand resistance in that it explicitly focuses on long term strategies for maintaining desired vegetation structure and composition rather than on the influence of vegetation structure and composition on fire behaviour. Strategies for building stand resilience to fire will depend on the forest type and specifics of the desired future condition but might include retention of large, fire-adapted trees or increasing live tree spatial heterogeneity. Although these strategies might also be used to build fire-resistant stands, the crucial difference is the assumption that fire will occur, which shifts the focus from changing fire behaviour to maintaining attributes consistent with the desired future conditions. Forest fires are also seen in many Indian forests and strategies to preent them and their study are important.

Resistance and Resilience to Spruce Beetle Outbreak

In the US, the magnitude of spruce beetle outbreaks has silviculturists and entomologists questioning what, if anything, can be done to reduce spruce beetle activity. Given the host specificity of the spruce beetle, planning for and evaluating resistance and resilience to outbreaks are fundamentally different from those processes for wildfires. The conceptual framework provides a template to evaluate resistance and resilience of spruce-dominated stands and landscapes faced with increasing populations of spruce beetle. Engelmann spruce stand resistance to spruce beetle is characterized as the influence of structure and composition on the likelihood of beetle populations increasing from within the stand, i.e., the likelihood is small that large numbers of beetles could develop within, and spread from, a resistant stand. Such resistance can result from a high percentage of non-host species, induced or constitutive resistance mechanisms, or low susceptibility associated with either low relative density and high vigour or young stands of small

spruce trees. Stand resistance is characterized as the structural and compositional attributes that negatively influence the beetle and can be manipulated with stand management. In contrast to methods intended to directly protect individual trees from successful colonization by beetles (removal of infested trees and insecticide treatments), building resistance via manipulation of stand structure and composition is a strategy intended to indirectly influence a beetle population.

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The conceptual framework explicitly differentiates resistance and resilience, focuses on appropriate scales, and provides a context for evaluation and manipulation: structure and composition. Application of the framework encourages silviculturists to think beyond very general, ambiguous goals of resistance and resilience and focuses attention on what is ultimately ecologically meaningful and silviculturally achievable.

Check Your Progress

3. What is resistance?
4. Define resilience.

5.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The objectives of the network are as follows:
   (i) to act as a regular mechanism of consultation between various agencies engaged in JFM work in the country and
   (ii) to obtain constant feedback from various stakeholders on the JFM programme for proper policy formulation and suitable direction to States.
2. SDG 15 aims for sustainable management of forests.
3. In general, resistance is the ability of a community to remain unchanged when challenged by disturbances.
4. Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.

5.5 SUMMARY

- Protection policies increased the hardships of vulnerable social groups by denying them access to forests. While the state took responsibility for managing forest resources, it did not have the commensurate resources to effectively manage and police the forests from traditional users.

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- Involvement of rural communities living close to forests in protection and management of forest resources is enshrined in the National Forest Policy 1988.
- Importance of the Joint Forest Management (JFM) programme is evident from the fact that the Government of India has constituted a "JFM Network" with the Inspector General of Forests, Government of India as the Chairman.
- The MDGs call for the integration of the principles of sustainable development into environmental policies.
- Community-based forestry, or participatory forestry, is particularly well placed to address poverty reduction. Community-based forestry is now well accepted and established in various countries in all regions, and programmes are beginning to generate financial and other benefits.
- National Forest Policy in India treats forests as environmental and social resource. With the initiative of assigning ownership of Non Timber forest Produce (NTFP) to the local communities including the grass root level democratic institution for enhancing their livelihood opportunities and also improving their income with the value addition.
- Introduction of the alien concept of private property began with the Permanent Settlement of the British in 1793 and the establishment of the 'Zamindari' system that conferred control over vast territories, including Adivasi territories, to designated feudal lords for the purpose of revenue collection by the British.
- The Imperial Forest Department was formed in 1864. The first Act for the regulation of forests was passed in 1865. It empowered the government to declare any land covered with trees or brushwood as government forest and to make rules to manage them.
- About 4.5% of the total land in the country is covered under protected areas, classified into national parks, wildlife sanctuaries and protected areas. The Wildlife (Protection) Act of 1972 provided for the administration of these areas. The act places several restrictions on the residents of villages in these areas.
- The 1990 guidelines on Tribal and Forest Interface expressly provides for speedy settlement of claims in relation to forest land, Regularization of Encroachments; Review of Disputed Claims over Forest Land; Regularization of Pattas & Leases; and Conversion of Forest Villages to Revenue Villages.
- Increasingly, forest management goals include building or maintaining resistance to disturbances in the face of climate change. Although many descriptive definitions for resistance and resilience exist, to evaluate whether specific management activities (silviculture) are effective, prescriptive characterizations are necessary.

- In general, resistance is the ability of a community to remain unchanged when challenged by disturbances, and resilience is "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" as originally defined by Holling (1973).
- In the US, a conceptual framework was introduced that explicitly differentiates resistance and resilience, denotes appropriate scales, and establishes the context for evaluation—structure and composition.

5.6 KEY WORDS

- **Forest policy:** Forest policy of a country specifies certain broad principles for the use of a nation's forest resources.
- **Joint forest management:** It was a government resolution which calls for management of forests by more than one party.
- **Silviculture:** It is the practice of controlling the growth, composition/ structure, and quality of forests to meet values and needs, specifically timber production.

5.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the two major reasons behind introducing JFM?
2. What kind of restrictions does the Wildlife (Protection) Act of 1972 place on the residents of villages of nearby protected areas?
3. What is land alienation?
4. What are protected areas?

Long-Answer Questions

1. Explain joint forest management.
2. Describe the resistance system to forest management with examples.
3. Analyse the National Forest Policy of India since the time it started till now.

5.8 FURTHER READINGS

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UNIT 6 FOREST MOVEMENTS AND EFFECTS OF URBANIZATION, INDUSTRIALIZATION AND NATIONALISM

Structure

6.0 INTRODUCTION

An environmental movement may be defined as a social or political movement for the conservation of environment and its improvement. Environmental movements in India have been concerned mainly with dams, displacement and resettlement. These have effectively articulated their agenda on the human consequences of tampering with the courses of natural resources, have initiated protest action against the forces and agencies responsible for environmental degradation. The traditional practices of worshipping plants, trees, forest, and rivers in India reflect the natural and social domains and the wisdom of observing unity in the living and the non-living world. The environmental movements in India include all categories of caste, race, religion, countries and also categories of species and the divisions of the organic and inorganic world. Important environmental movements in India are Chipko Movement, Bishnoi Movement, Appiko Movement, Silent Valley Movement, Narmada Bachao Movement, Tehri Dam Movement, etc. In this unit, we will discuss the history of environmentalism in India and also the impact of urbanization and industrialization on environment.

6.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the history of environmentalism and various movements associated with it
- Explain forest movements in India
- Analyse the effects of urbanisation and industrialization on environment
- Discuss the impact of nationalism on environment in India

6.2 FOREST AND ENVIRONMENT MOVEMENTS FROM 1921-42

Before leaning about the popular forest movements. Let's discuss the history of environment movements in the world.

History of Environmental Movement

Concern for the impact on human life of problems such as air and water pollution dates to at least Roman times. Pollution was associated with the spread of epidemic disease in Europe between the late 14th century and the mid-16th century, and soil conservation was practiced in China, India and Peru as early as 2,000 years ago. In general, however, such concerns did not give rise to public activism.

The contemporary environmental movement arose primarily from concerns in the late 19th century about the protection of the countryside in Europe and the wilderness in the United States and the health consequences of pollution during the Industrial Revolution. In opposition to the dominant political philosophy of the time, liberalism—which held that all social problems, including environmental ones, could and should be solved through the free market—most early environmentalists believed that government rather than the market should be charged with protecting the environment and ensuring the conservation of resources. An early philosophy of resource conservation was developed by Gifford Pinchot (1865–1946), the first chief of the U.S. Forest Service, for whom conservation represented the wise and efficient use of resources. Also in the United States at about the same time, a more strongly bio-centric approach arose in the preservationist philosophy of John Muir (1838–1914), founder of the Sierra Club, and Aldo Leopold (1887–1948), a professor of wildlife management who was pivotal in the designation of Gila National Forest in New Mexico in 1924 as America's first national wilderness area. Leopold introduced the concept of a land ethic, arguing that humans should transform themselves from conquerors of nature into citizens of it; his essays, compiled posthumously in *A Sand County Almanac* (1949), had a significant influence on later bio-centric environmentalists.

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Environmental organizations established from the late 19th to the mid-20th century were primarily middle-class lobbying groups concerned with nature conservation, wildlife protection, and the pollution that arose from industrial development and urbanization. There were also scientific organizations concerned with natural history and with biological aspects of conservation efforts.

Although the United States led the world in such efforts during this time, other notable conservation developments were also occurring in Europe and Oceania. For example, a group of Swiss scientists and conservationists convinced the government to set aside 14,000 hectares (roughly 34,600 acres) of land in the Swiss Alps as Europe's first national park by 1914. In New Zealand, the Native Bird Protection Society (later the Royal Forest and Bird Protection Society, or Forest & Bird) arose in 1923 in response to the devastation of Kapiti Island by livestock.

Beginning in the 1960s, the various philosophical strands of environmentalism were given political expression through the establishment of "green" political movements in the form of activist non-governmental organizations and environmentalist political parties. Despite the diversity of the environmental movement, four pillars provided a unifying theme to the broad goals of political ecology: protection of the environment, grassroots democracy, social justice, and nonviolence. However, for a small number of environmental groups and individual activists who engaged in eco-terrorism, violence was viewed as a justified response to what they considered the violent treatment of nature by some interests, particularly the logging and mining industries. The political goals of the contemporary green movement in the industrialized West focused on changing government policy and promoting environmental social values. Examples include the campaigns in Tasmania in the 1970s and '80s to block the flooding of Lake Pedder and the damming of the Franklin River; protests in the United States and western Europe against nuclear power development, especially following the catastrophic accidents at Three Mile Island (1979) and Chernobyl (1986); the related decades-long controversy surrounding uranium mining in Australia's Northern Territory, including at the Jabiluka mine; protests against deforestation in Indonesia and the Amazon basin; and campaigns in several countries to limit the volume of greenhouse gases released through human activities. In the less-industrialized or developing world, environmentalism has been more closely involved in "emancipatory" politics and grassroots activism on issues such as poverty, democratization, and political and human rights, including the rights of women and indigenous peoples. Examples include the Chipko movement in India, which linked forest protection with the rights of women, and the Assembly of the Poor in Thailand, a coalition of movements fighting for the right to participate in environmental and development policies.

The early strategies of the contemporary environmental movement were self-consciously activist and unconventional, involving direct-protest actions designed to obstruct and to draw attention to environmentally harmful policies and

projects. Other strategies included public-education and media campaigns, community-directed activities, and conventional lobbying of policy makers and political representatives. The movement also attempted to set public examples in order to increase awareness of and sensitivity to environmental issues. Such projects included recycling, green consumerism (also known as "buying green"), and the establishment of alternative communities, including self-sufficient farms, workers' cooperatives, and cooperative-housing projects.

The electoral strategies of the environmental movement included the nomination of environmental candidates and the registration of green political parties. These parties were conceived of as a new kind of political organization that would bring the influence of the grassroots environmental movement directly to bear on the machinery of government, make the environment a central concern of public policy, and render the institutions of the state more democratic, transparent, and accountable. The world's first green parties—the Values Party, a nationally based party in New Zealand, and the United Tasmania Group, organized in the Australian state of Tasmania—were founded in the early 1970s. The first explicitly green member of a national legislature was elected in Switzerland in 1979; later, in 1981, four greens won legislative seats in Belgium. Green parties also have been formed in the former Soviet bloc, where they were instrumental in the collapse of some communist regimes, and in some developing countries in Asia, South America, and Africa, though they have achieved little electoral success there.

The most successful environmental party has been the German Green Party (die Grünen), founded in 1980. Although it failed to win representation in federal elections that year, it entered the Bundestag (parliament) in both 1983 and 1987, winning 5.6 percent and 8.4 percent of the national vote, respectively. The party did not win representation in 1990, but in 1998 it formed a governing coalition with the Social Democratic Party, and the party's leader, Joschka Fischer, was appointed as the country's foreign minister.

Throughout the last two decades of the 20th century, green parties won national representation in a number of countries and even claimed the office of mayor in European capital cities such as Dublin and Rome in the mid-1990s. Outside Europe, New Zealand's Green Party, which was reconstituted from the former Values Party in 1990, won 7 percent of the vote in the 1990 general election; its influence had grown to 9 of the country's 121 parliamentary seats by 2002 and to 14 parliamentary seats by 2014.

By this time green parties had become broad political vehicles, though they continued to focus on the environment. In developing party policy, they attempted to apply the values of environmental philosophy to all issues facing their countries, including foreign policy, defense, and social and economic policies.

Despite the success of some environmental parties, environmentalists remained divided over the ultimate value of electoral politics. For some, participation in elections is essential because it increases the public's awareness of environmental

issues and encourages traditional political parties to address them. Others, however, have argued that the compromises necessary for electoral success invariably undermine the ethos of grassroots democracy and direct action. This tension was perhaps most pronounced in the German Green Party. The party's Realos (realists) accepted the need for coalitions and compromise with other political parties, including traditional parties with views sometimes contrary to that of the Green Party. By contrast, the Fundis (fundamentalists) maintained that direct action should remain the major form of political action and that no pacts or alliances should be formed with other parties. Likewise, in Britain, where the Green Party achieved success in some local elections but failed to win representation at the national level (though it did win 15 percent of the vote in the 1989 European Parliament elections), this tension was evidenced in disputes between so-called "electoralists" and "radicals."

The implementation of internal party democracy also caused cracks within environmental parties. In particular, earlier strategies such as continuous policy involvement by party members, grassroots control over all party institutions and decisions, and the legislative rotation of elected members to prevent the creation of career politicians were sometimes perceived as unhelpful and disruptive when green parties won representation to local, national, or regional assemblies.

By the late 1980s environmentalism had become a global as well as a national political force. Some environmental non-governmental organizations (e.g., Greenpeace, Friends of the Earth, and the World Wildlife Fund) established a significant international presence, with offices throughout the world and centralized international headquarters to coordinate lobbying campaigns and to serve as campaign centres and information clearinghouses for their national affiliate organizations. Transnational coalition building was and remains another important strategy for environmental organizations and for grassroots movements in developing countries, primarily because it facilitates the exchange of information and expertise but also because it strengthens lobbying and direct-action campaigns at the international level.

Through its international activism, the environmental movement has influenced the agenda of international politics. Although a small number of bilateral and multilateral international environmental agreements were in force before the 1960s, since the 1972 United Nations Conference on the Human Environment in Stockholm, the variety of multilateral environmental agreements has increased to cover most aspects of environmental protection as well as many practices with environmental consequences, such as the burning of fossil fuels, the trade in endangered species, the management of hazardous waste, especially nuclear waste, and armed conflict. The changing nature of public debate on the environment was reflected also in the organization of the 1992 United Nations Conference on Environment and Development (the Earth Summit) in Rio de Janeiro, Brazil, which was attended by some 180 countries and various business groups, non-governmental organizations, and the media. In the 21st century the environmental

movement has combined the traditional concerns of conservation, preservation, and pollution with more contemporary concerns with the environmental consequences of economic practices as diverse as tourism, trade, financial investment, and the conduct of war. Environmentalists are likely to intensify the trends of the late 20th century, during which some environmental groups increasingly worked in coalition not just with other emancipatory organizations, such as human rights and indigenous-peoples groups, but also with corporations and other businesses.

Forest Movements in India

The green legislative issues or green development or ecological development can be characterized as a social development for the preservation of the climate or for the improvement of the state strategy particularly slanted towards the climate. As such, it is the development to ensure the climate through changes in open strategy. Here, we are giving a concise history of the Environmental Movements in India. Most of these are post-independence movements. Historically, in British India, two popular movements of Bhil and Santhals were related to forest and tribal rights.

1. **Bishnoi Movement:** Bishnoi is a strict order found in the Western Thar Desert and northern conditions of India. It was established by Guru Maharaj Jambaji in 1485 AD in the Marwar (Jodhpur) desert area of western Rajasthan, India. It is peaceful local area of nature admirers. This development was begun by sage Sombaji around 1700 AD against deforestation. After that Amrita Devi sent the development. The 363 individuals from the Bishnoi people group were murdered in the dissent. At the point when the lord of this locale came to know the dissent and murdering then he raced to the town and apologized, and proclaimed the district as ensured territory. It is vital that this enactment still exists today.
2. **Chipko Movement:** It was dispatched from Gopeshwar in Chamoli area, Uttarakhand in 1973. The development was to forestall illicit cutting of trees in the Himalayan district (Uttarakhand). SunderlalBahuguna and Chandi Prasad Bhatt were the heads of this development. The most eminent attributes of this development were the association of ladies.
3. **Appiko Movement:** In 1983, on the lines of Chipko Movement, Pandurang Hegde dispatched a development which came to be known as Appiko Movement in Karnataka. Its fundamental targets were afforestation just as advancement, protection and legitimate usage of timberlands in the best way. The significance of “appiko” is to communicate one’s fondness for a tree by accepting it.
4. **Silent Valley Movement**: It is a zone of tropical evergreen woodlands in Kerala. It is extremely wealthy in biodiversity. The preservationists and the nearby individuals unequivocally protested the hydel power project being set up here in 1973. Under tension, the public authority needed to pronounce it the public hold timberlands in 1985.

5. **Wilderness BachaoAndola:** The ancestral local area of Singhbhum region of Jharkhand (Previously, it was a region of India during the British Raj, part of the Chota Nagpur Division of the Bengal Presidency) fomented against the backwoods strategy of the Government in 1982. The Government needed to supplant the regular soil, woods with the expensive teak. Numerous tree huggers allude to this development as "Ravenousness Game Political Populism".
6. **Narmada Bachao Movement:** The tree huggers and the neighbourhood individuals began challenge the structure of Dams on the Narmada for the creation of hydro-power since 1985 which was prominently known as Narmada Bachao Aandolan. Medha Patkar has been the head of this aandolan who got support from the Arundhati Roy, Baba Amte and Aamir Khan.
7. **Tehri Dam Conflict:** This development was begun by the locals around 1980s and 1990s on the grounds that the dam task would built in the seismic delicate locale and individuals believe that it causes submergence of woodland territories alongside Tehri town. In spite of dissent, the development of the dam is being completed with police assurance as Sunderlal Bahuguna sat on fast unto death. After affirmation from the public authority to survey the venture, Bahuguna finished his fast unto death and the development went on, however at a more slow speed.

Subsequently, we can say, various grass root natural developments were begun against the formative exercises that have jeopardized the biological equilibrium that changes the public approach more inclined towards the climate.

Check Your Progress

1. What was the philosophy of liberalism?
2. Why is the participation of environmental parties essential in elections?
3. What were the fundamental targets of Appiko Movement?

6.3 EFFECTS OF URBANIZATION AND INDUSTRIALIZATION

Urbanization and industrialization have impacted forests in a considerable manner. Here, we will discuss about their impacts on forests and wildlife. But before we learn about the effects. Let's brefly discuss environment degradation.

Underlying Causes of Environmental Degradation

Environmental degradation is a result of the dynamic interplay of socio-economic, institutional and technological activities. Environmental changes may be driven by many factors including economic growth, population growth, urbanization,

intensification of agriculture, rising energy use and transportation. Poverty still remains a problem at the root of several environmental problems.

1. Social Factors

Population: Population is an important source of development, yet it is a major source of environmental degradation when it exceeds the threshold limits of the support systems. Unless the relationship between the multiplying population and the life support system can be stabilized, development programmes, howsoever, innovative are not likely to yield desired results. Population impacts the environment primarily through the use of natural resources and production of wastes and is associated with environmental stresses like loss of biodiversity, air and water pollution and increased pressure on arable land. India supports 17 per cent of the world population on just 2.4 per cent of world land area. Its current rate of population growth at 1.85 per cent continues to pose a persistent population challenge. In view of the links between population and environment, a vigorous drive for population control need hardly be over emphasised.

Poverty: Poverty is said to be both cause and effect of environmental degradation. The circular link between poverty and environment is an extremely complex phenomenon. Inequality may foster unsustainability because the poor, who rely on natural resources more than the rich, deplete natural resources faster as they have no real prospects of gaining access to other types of resources. Moreover, degraded environment can accelerate the process of impoverishment, again because the poor depend directly on natural assets. Although there has been a significant drop in the poverty ratio in the country from 55 percent in 1973 to 36 percent in 1993-94, the absolute number of poor have, however, remained constant at around 320 million over the years. An acceleration in poverty alleviation is imperative to break this link between poverty and the environment.

Urbanization: Lack of opportunities for gainful employment in villages and the ecological stresses is leading to an ever increasing movement of poor families to towns. Mega cities are emerging and urban slums are expanding. There has been an eightfold increase in urban population over 1901-1991. During the past two decades of 1971-91, India’s urban population has doubled from 109 million to 218 million and is estimated to reach 300 million by 2000 AD. Such rapid and unplanned expansion of cities has resulted in degradation of urban environment. It has widened the gap between demand and supply of infrastructural services such as energy, housing, transport, communication, education, water supply and sewerage and recreational amenities, thus depleting the precious environmental resource base of the cities. The result is the growing trend in deterioration of air and water quality, generation of wastes, the proliferation of slums and undesirable land use changes, all of which contribute to urban poverty.

2. Economic Factors

To a large extent, environmental degradation is the result of market failure, that is, the non- existent or poorly functioning markets for environmental goods and services. In this context, environmental degradation is a particular case of consumption or production externalities reflected by divergence between private and social costs (or benefits). Lack of well-defined property rights may be one of the reasons for such market failure. On the other hand, market distortions created by price controls and subsidies may aggravate the achievement of environmental objectives.

The level and pattern of economic development also affect the nature of environmental problems. India's development objectives have consistently emphasised the promotion of policies and programmes for economic growth and social welfare. Between 1994-95 and 1997-98, the Indian economy has grown a little over 7 per cent per annum: the growth of industrial production and manufacturing averaging higher at 8.4 per cent and 8.9 percent respectively during these years. The manufacturing technology adopted by most of the industries has placed a heavy load on environment especially through intensive resource and energy use, as is evident in natural resource depletion (fossil fuel, minerals, timber), water, air and land contamination, health hazards and degradation of natural eco-systems. With high proportion fossil fuel as the main source of industrial energy and major air polluting industries such as iron and steel, fertilizers and cement growing, industrial sources have contributed to a relatively high share in air pollution. Large quantities of industrial and hazardous wastes brought about by expansion of chemical based industry has compounded the wastes management problem with serious environmental health implications.

Transport activities have a wide variety of effects on the environment such as air pollution, noise from road traffic and oil spills from marine shipping. Transport infrastructure in India has expanded considerably in terms of network and services. Thus, road transport accounts for a major share of air pollution load in cities such as Delhi. Port and harbour projects mainly impact on sensitive coastal eco systems. Their construction affects hydrology, surface water quality, fisheries, coral reefs and mangroves to varying degrees. Direct impacts of agricultural development on the environment arise from farming activities which contribute to soil erosion, land salinization and loss of nutrients. The spread of green revolution has been accompanied by over exploitation of land and water resources, and use of fertilizers and pesticides have increased many fold. Shifting cultivation has also been an important cause of land degradation. Leaching from extensive use of pesticides and fertilizers is an important source of contamination of water bodies. Intensive agriculture and irrigation contribute to land degradation particularly salinization, alkalization and water logging.

3. Institutional Factors

The Ministry of Environment & Forests (MOEF) is responsible for protection, conservation and development of environment. The Ministry works in close collaboration with other Ministries, State Governments, Pollution Control Boards and a number of scientific and technical institutions, universities, non-Governmental organisations, etc. Environment (Protection) Act, 1986 is the key legislation governing environment management. Other important legislations in the area include the Forest (Conservation) Act, 1980 and the Wildlife (Protection) Act, 1972. The weakness of the existing system lies in the enforcement capabilities of environmental institutions, both at the centre and the state. There is no effective coordination amongst various Ministries/Institutions regarding integration of environmental concerns at the inception/planning stage of the project. Current policies are also fragmented across several Government agencies with differing policy mandates. Lack of trained personnel and comprehensive database delay many projects. Most of the State Government institutions are relatively small suffering from inadequacy of technical staff and resources. Although overall quality of Environmental Impact Assessment (EIA) studies and the effective implementation of the EIA process have improved over the years, institutional strengthening measures such as training of key professionals and staffing with proper technical persons are needed to make the EIA procedure a more effective instrument for environment protection and sustainable development. All efforts should be directed towards strengthening institutions, scientifically and technologically, training the existing manpower, and exchanging information and integrating knowledge by complementing the efforts of agencies dealing with environment. Each of us has a role to play in rehabilitating our environment. Let us not forget that the environment is nothing but an extension of the individual. We belong to the earth; the earth does not belong to us. Land, air and water are complex interrelated systems. Even if one is affected, the effects are reflected on the others, and their constituents. Therefore, proper resource utilization, and conservation and maintenance of the ecological balance is the need of the hour.

Effect of Urbanization

Nature and humankind are an indistinguishable part of life that incorporates land, water, air, space, energy, vegetation which are interconnected, interrelated and reliant. There are limitless types of life on earth. Man is one among the numerous animal groups contending with all others for endurance. For the sake of progress, humanity has changed from being agrarian to narcissistic to such an extent that improvement as it were has gotten inseparable from ecological debasement and progress with contamination. There is likewise a growing acknowledgment that the unpredictable utilization of common assets has led to difficult issues.

Air Pollution: Clear air is instrumental for our survival. It is one of the “five spirits” or “Panchaboothas” pondered favoured in India. India’s metropolitan networks have become lethal gas chambers. Vehicular defilement is the essential

driver of air pollution. Delhi is the fourth most polluted city on earth. In the metropolitan territories, the air pollution level has outperformed the pre-defined standards set by WHO. It has been evaluated that 2.0 million Indians die yearly due to air pollution. India is spending Rs. 4,550 crore for treating harmful issues due to air pollution. Increase in ordinary temperature, destructive storm over certain metropolitan territories and smoke on account of wood fires inside homes are some of the various causes of air pollution. India is one of the signatories of the overall strategy to control pollution. Accordingly, diesel vehicles and 15-year-old vehicles are to be restricted to control vehicular pollution in metropolitan regions like Delhi, Mumbai, Hyderabad, etc. Vehicle production checks have been made needed for all vehicles. To control the pollution levels precipitators, scrubbers and suitable channels ought to be fundamentally presented. Real courses of action under the Air (Pollution, Prevention and Control) Act have furthermore been taken to discard the practices that lead to pollution.

Water pollution: Water is the fundamental requirement for all lives. Water received as precipitation has been surveyed to be 4000 km3 consistently. Be that as it may, it has been possible to explore only 690 km3 for beneficial use. The ground water potential is surveyed at 450 km3. The case of water use in India is with the ultimate objective that 93% is used by the agrarian zone and 3.73% by the local region. 80% of the 14 suffering streams in India are polluted with sewage. Current effluents, agrarian run-off, dumping of unsafe materials in streams and other water bodies are the explanation behind water pollution.

Waste management will relieve the stress on the natural resources and will provide a clean and sustainable environment. Every type of pollution has an effect on the human body. Only the scale may differ. The effect depends on the severity of pollution to which a person has been exposed to. Air pollution from vehicles, industries and dust results in respiratory disorders like asthma, bronchitis, bronchial irritation, etc. India spends a sizable portion of its revenue on health problems. In the 36 major cities of India this accounts for about Rs. 9000 crore per year. Noise pollution from heavy traffic, loudspeakers and industries affect the human system. A noise level of 80 decibels creates tension and increases blood pressure. Continuous exposure to noise levels above 85 db results in tinnitus, while a level of 115-120 db can result in permanent deafness and at times leads to fatigue. Even the foetus in the mother's womb is disturbed by noise pollution.

Impact of Industrialization

Centuries back, when there was no dynamic growing of enormous urban communities and enterprises, nature had the option to defeat contamination and keep air genuinely clean without outside assistance. The breeze and downpour as common rescuers dissipated gases and washed away the residue. Nonetheless, with expanding industrialization and urbanization, the nature's framework cannot adapt to contamination and clean the climate normally. In comparison to volcanoes,

tropical storms, timberland fires and other catastrophic events, humans produce substantially more wastes that contaminate the climate.

In this way, the negative effect of industrialization and urbanization measures on the climate is radical and very expansive. Industrialization for the sake of development has stacked gigantic tension on climate. Industrialization and climate in the agricultural nations attempts to run hand to hand. However, purposely or unwittingly, industrialization ran quicker without really focusing on climate to dominate the race. Industrialization has expanded at an exponential growth.

Since the start of nineteenth century, humans have started to effectively utilize regular assets and intercede in the area of biosphere – a living piece of our planet. Just throughout the previous 100 years, the advancement of industry has brought about mechanical cycles, adverse results that individuals could not foresee. Urban areas with a populace of at least 1,000,000 showed up and their extension cannot be halted. This is the aftereffect of extraordinary creations and accomplishments of humankind. Gradually, we have changed our air and its science.

These days manufacturing plants are spread around the planet and air contamination has become a vital part of our life.

Industrial effluents: Effluent is by and large viewed as water contamination, for example, the outpouring from a sewage treatment office or the waste water release from modern offices. More than 73 million days are lost every year because of water related sicknesses. A gushing sump siphon, for example, siphons waste from latrines introduced under a primary sewage line. With regards to squander water treatment plants, emanating that has been dealt with is now and then called auxiliary profluent, or rewarded gushing.

This cleaner profluent is then used to take care of the microorganisms in bio-channels. A nuclear energy plant, the yield of the cooling framework might be alluded to as the profluent cooling water, which is recognizably hotter than the climate. Gushing just alludes to fluid release.

Contaminated air: Air contamination alludes to the presence of substance, natural, and particulate issue, and poisons the environment around the living spaces. When breathed in, it influences the human organic framework, and negatively affects the personal satisfaction, with the assault of various respiratory plot problems.

It is a condition set off by the presence of air-borne toxins noticeable all around us. These toxins could either be the aftereffect of substance emanations or the particulate material from natural waste. The condition has arrived at disturbing extents in the advanced world, with enormous scope industrialization and vehicle-outflows being the essential guilty parties. The contaminations that are air-borne cause a great deal of mischief to people and creatures, other than lasting harm to the regular habitat.

Impacts of Air Pollution on Humans: Various disease and medical problems like cardiopulmonary disease, pneumonia, premature mortality, heart attack,

asthma, difficulty in breathing, wheezing and coughing, acute vascular dysfunction, thrombosis/thrombus formation, cystic fibrosis, etc., are caused due to air pollution.

Impact of ozone depleting substances: Ozone depleting substances are man-made gases that destroy ozone once they reach the ozone layer. The ozone layer sits in the upper atmosphere and reduces the amount of harmful ultra violet radiation that reaches Earth from the sun. Ultraviolet radiation can have detrimental effects on both humans and the environment. For instance inducing skin cancer and cataracts, distorting plant growth and damaging the marine environment.

World over, the governments are getting progressively worried about accomplishing and showing their ecological presentation in view of the developing impulses from intense enactments and mounting public pressing factors. Ecological debacles, for example, Bhopal misfortune, Rhine contamination, Chernobyl catastrophe, Ozone Layer Depletion have prompted governments everywhere in the world to take action.

Contaminations influence climate as well as social and political lives of individuals. On one hand the headways of science and technology have added to the human comfort by giving us vehicles, electrical apparatus, better medication, better compound to control destructive bugs and nuisance and on the other hand we also face the challenge of confronting contamination and search for the sustainable solutions.

The decay of climate and quick exhaustion of common assets undermine the maintainability of financial turn of events. Perhaps the most complex difficulty for us is to look for ways to maintain a balance between economic and developmental activities and ecological conduct.

Check Your Progress

4. Which factors drive the environmental changes?
5. When does population become a source of environmental degradation?

6.4 IMPACT OF NATIONALISM ON ENVIRONMENT IN INDIA

The natural concern was negligible during the time of Gandhi, however his thoughts on Village Swaraj, decentralization, Swadeshi, Sarvodya, etc., made him a supporter of environmentalism. He is regularly considered as a man with profound biological view. The thoughts of Gandhi have been generally utilized by various floods of natural way of thinking like green, profound biology, and so on and distinctive ecological developments across the globe. A prominent natural mastermind Ramachandra Guha recognized three unmistakable strands in Indian Environmentalism, the Crusading Gandhians, Appropriate Technologists and Ecological Marxists. He saw that, not at all like the third one, the initial two strands

depend intensely on Gandhi. The motivation behind this paper is to distinguish the Gandhian components utilized by the Ecological Marxists in India. The Silent Valley Movement from Kerala is taken as a contextual investigation to examine how biological Marxists resort to Gandhian strategies to battle against natural unfairness. The job of Kerala Sastra Sahitya Parishad (KSSP), a People's Science Movement (PSM) from Kerala with a Marxist foundation is concentrated to comprehend various techniques they utilized in the development. It is seen that the procedures embraced all through the development are provoked by Gandhian techniques as recently utilized by other natural developments like Chipko.

Ecological Movements in India is a reaction to the natural difficulties looked by the country from the hour of expansionism to the present for the sake of advancement and innovation. These developments are regularly immediate signs of Gandhian peacefulness and harmony making. Gandhian peacefulness had been acknowledged by the ecological developments as their great goal. Green developments in India and outside have guaranteed a liking with Gandhi. Petra Kelly, originator of German green coalition, wrote in 1990 that the green groups had been straightforwardly affected by Gandhi in reasoning that "a way of life and a strategy for creation which depend on an interminable stock of crude materials and an extravagant utilization of these crude materials produce the rationale in the rough appointment of crude materials from other countries." Arne Naess, father of 'deep ecology' additionally contends that his work for ecosophy, was created out of his work on Spinoza and Gandhi. He clarifies that Gandhi showed the inside connection between self-acknowledgment, peacefulness and has been called bio-round populism, and brings up that he was unavoidably impacted by Mahatma's transcendentalism which added to keeping him (the mahatma) going until his death. It was the commitment of Gandhi to the way of thinking of Deep Ecology that made him a victor of environmentalism. Both Gandhi and Naess accepted that 'self-acknowledgment' is fundamental to see any sort of issues or clashes.

Environmentalism as a development began in India in 1970s and prospered with the Chipko movement. Not all like the western ecological movements which addressed the upper and working class. Indian environmental movements implied the "environmentalism of the poor". These movements are regularly driven by the labourers and native individuals, particularly the woman. It "joins issues of ecology with question of basic freedoms, identity and distributive justice". Often it starts with endeavours advancing local area improvement, education and political strengthening and every now and then, moves to a fight to figure out who own/ controls the utilization of land. The majority of these movements depended on the Gandhian estimations of natural reasonability and moderation and followed the Gandhian model of decentralized vote based system and village Swaraj. Simultaneously, a few movements like Silent Valley movement from Kerala represent the blend of both Gandhian and Marxian philosophies.

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Check Your Progress

6. What made Gandhi a supporter of environmentalism?
7. Which three unmistakable strands in Indian Environmentalism did Ramachandra Guha recognize?

6.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Liberalism held that all social problems, including environmental ones, could and should be solved through the free market.
2. The participation of environmental parties in elections is essential because it increases the public's awareness of environmental issues and encourages traditional political parties to address them.
3. The fundamental targets of Appiko Movement were afforestation just as advancement, protection and legitimate usage of timberlands in the best way.
4. Environmental changes may be driven by many factors including economic growth, population growth, urbanization, intensification of agriculture, rising energy use and transportation.
5. Population is an important source of development, yet it is a major source of environmental degradation when it exceeds the threshold limits of the support systems.
6. The natural concern was negligible during the time of Gandhi, however his thoughts on Village Swaraj, decentralization, Swadeshi, Sarvodya, etc., made him a supporter of environmentalism.
7. A prominent natural mastermind Ramachandra Guha recognized three unmistakable strands in Indian Environmentalism, the Crusading Gandhians, Appropriate Technologists and Ecological Marxists.

6.6 SUMMARY

- Pollution was associated with the spread of epidemic disease in Europe between the late 14th century and the mid-16th century, and soil conservation was practiced in China, India and Peru as early as 2,000 years ago.
- An early philosophy of resource conservation was developed by Gifford Pinchot (1865–1946), the first chief of the U.S. Forest Service, for whom conservation represented the wise and efficient use of resources.

- Environmental organizations established from the late 19th to the mid-20th century were primarily middle-class lobbying groups concerned with nature conservation, wildlife protection, and the pollution that arose from industrial development and urbanization.
- Beginning in the 1960s, the various philosophical strands of environmentalism were given political expression through the establishment of "green" political movements in the form of activist non-governmental organizations and environmentalist political parties.
- The early strategies of the contemporary environmental movement were self-consciously activist and unconventional, involving direct-protest actions designed to obstruct and to draw attention to environmentally harmful policies and projects.
- The electoral strategies of the environmental movement included the nomination of environmental candidates and the registration of green political parties.
- Green parties also have been formed in the former Soviet bloc, where they were instrumental in the collapse of some communist regimes, and in some developing countries in Asia, South America, and Africa, though they have achieved little electoral success there.
- In developing party policy, the green parties attempted to apply the values of environmental philosophy to all issues facing their countries, including foreign policy, defense, and social and economic policies.
- Transnational coalition building was and remains another important strategy for environmental organizations and for grassroots movements in developing countries, primarily because it facilitates the exchange of information and expertise but also because it strengthens lobbying and direct-action campaigns at the international level.
- In the 21st century the environmental movement has combined the traditional concerns of conservation, preservation, and pollution with more contemporary concerns with the environmental consequences of economic practices as diverse as tourism, trade, financial investment, and the conduct of war.
- Bishnoi is a strict order found in the Western Thar Desert and northern conditions of India. It was established by Guru Maharaj Jambaji in 1485 AD in the Marwar (Jodhpur) desert area of western Rajasthan, India. It is peaceful local area of nature admirers.
- Environmental degradation is a result of the dynamic interplay of socio-economic, institutional and technological activities. Environmental changes may be driven by many factors including economic growth, population growth, urbanization, intensification of agriculture, rising energy use and transportation.

- Population impacts the environment primarily through the use of natural resources and production of wastes and is associated with environmental stresses like loss of biodiversity, air and water pollution and increased pressure on arable land.
- Inequality may foster unsustainability because the poor, who rely on natural resources more than the rich, deplete natural resources faster as they have no real prospects of gaining access to other types of resources.
- To a large extent, environmental degradation is the result of market failure, that is, the non- existent or poorly functioning markets for environmental goods and services. In this context, environmental degradation is a particular case of consumption or production externalities reflected by divergence between private and social costs (or benefits).
- The Ministry of Environment & Forests (MOEF) is responsible for protection, conservation and development of environment. The Ministry works in close collaboration with other Ministries, State Governments, Pollution Control Boards and a number of scientific and technical institutions, universities, non-Governmental organisations, etc.
- The breeze and downpour as common rescuers dissipated gases and washed away the residue. Nonetheless, with expanding industrialization and urbanization, the nature's framework cannot adapt to contamination and clean the climate normally.
- A prominent natural mastermind Ramachandra Guha recognized three unmistakable strands in Indian Environmentalism, the Crusading Gandhians, Appropriate Technologists and Ecological Marxists.
- Ecological Movements in India is a reaction to the natural difficulties looked by the country from the hour of expansionism to the present for the sake of advancement and innovation. These developments are regularly immediate signs of Gandhian peacefulness and harmony making.
- Environmentalism as a development began in India in 1970s and prospered with the Chipko movement.

6.7 KEY WORDS

- **Liberalism:** It refers to a political and social philosophy that promotes individual rights, civil liberties, democracy, and free enterprise.
- **Green political party:** It is a formally organized political party based on the principles of green politics, such as social justice, environmentalism and nonviolence.
- **Urbanization:** It refers to the population shift from rural to urban areas, the decrease in the proportion of people living in rural areas, and the ways in which societies adapt to this change.

- **Environmental degradation:** It is the deterioration of the environment through depletion of resources such as air, water and soil; the destruction of ecosystems; habitat destruction; the extinction of wildlife; and pollution.

6.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. How and what were the early strategies of the contemporary environmental movement?
2. How does population impact the environment?
3. What are the economic factors that influence the environment?
4. What do you mean by the environmentalism of the poor?

Long-Answer Questions

1. Explain how the environmental movement has influenced the agenda of international politics.
2. Describe the forest developments in India that took place in history.
3. Analyse the impact of nationalism on environmentalism movements.

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UNIT 7 ENVIRONMENT EDUCATION AND PROTECTION

NOTES

Structure

7.0 INTRODUCTION

Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. Environmental education does not advocate a particular viewpoint or course of action. Rather, environmental education teaches individuals how to weigh various sides of an issue through critical thinking and it enhances their own problem-solving and decision-making skills. Environmental education increases public awareness and knowledge of environmental issues, teaches individuals critical-thinking and enhances individuals' problem-solving and decision-making skills. In this unit, we will study in detail about the meaning, significance and scope of environmental education and the methods to impart environmental education along with the institutions set up for environmental protection.

7.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the meaning and importance of environmental education
- Discuss the importance points made by various conferences and meetings on the need of environmental education
- Explain the nature and scope of environmental education

- State the formal and informal methods of imparting environmental education in India
- List the organizations established for environmental protection

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7.2 ENVIRONMENTAL EDUCATION

Environmental education is an important segment within the educational system. In many countries government supported programmes are constituted which are pursued by social groups, scientific community and educational institutions.

The main objectives of such programmes are:

- To overcome the environmental crisis
- To understand the factors, causes and find solutions to the environmental problems
- To evaluate and analyse problems in the management of natural resources
- To evaluate the success and failure in implementing educational tasks
- To develop ability to assess environmental situations which are leading to environmental damages
- To develop relationship between social, economic and physical factors which are mutually responsible for various negative outcomes
- To provide feedback for the future generation
- To define economy and set up the limits of the use of natural resources
- To make behavioural changes in everybody's life as a consumer, industrial producer, employee, citizen, policymaker, traveller, tourist, farmer, or student
- To integrate Gandhian principles and values as a part of environmental education

Need for Environmental Education

The pursuit of sustainable development and environmental conservation policies, objectives and targets requires the public to be sufficiently sensitized about the multiple dimensions of environment and development. Awareness and understanding of environmental issues provide the basis and rationale for commitment and meaningful action towards environmentally sound and sustainable development.

Environmental education is now being seen as an instrument and a process that enables participation and learning by people of all ages, based on two-way communication rather than the old paradigm of a one-way flow of information, from teachers to pupils. The content and substance of environmental education is also undergoing review and change. Reorienting education as a whole towards sustainability involves the various levels of formal, non-formal and informal education at all levels of society. Environmental education has developed within the conceptual

framework that emerged from the first international conference in Tbilisi (1977) and is now seen as education for sustainability. This allowed environmental education to address the broad range of issues and concerns included in *Agenda 21* and others which evolved through the meetings of the Commission on Sustainable Development (UNESCO 1997).

The key international conventions on environment place a high value on public awareness, education and training and obtaining information through monitoring as essential elements for the success of the conventions. For example, the Convention on Biological Diversity emphasizes the importance of public education and awareness through promoting and encouraging measures required for the conservation of biological diversity.

Since the convention came into force in December 1995, the contracting parties (countries) have been motivated to address issues related to education and awareness on biodiversity.

In addition, countries in the region recognize the immensity of the challenges they face, and of the vital role that environmental education can play in meeting these challenges. There is a growing perception by governments for the need to integrate environmental education information and communication into the country's on-going programmes. As a result of the *Agenda 21*, the level of cooperation and collaboration between environmental and the educational institutions has increased. In some countries, governmental environmental agencies have statutory requirements to engage in activities related to environmental education and awareness. For example, the Malaysian Department of Environment has established an educational division under the Environmental Quality Act, which is actively engaged in promoting and implementing a variety of activities.

In many countries of the Asian and the Pacific Region environmental topics have been included in education courses, through integrating environmental concerns in other subjects and through specific courses for the environment. Government, NGOs, educational institutions and media have undertaken some serious efforts to meet the growing environmental challenges by promoting environmental education, information and communication in their respective countries. Activities such as green bank, green press, eco-clubs, eco-policies, eco-farming and eco-harvesting; are emerging in the region. Special economic incentives (such as subsidy, tax-exemption and other incentives) are provided to schools in some countries where environmental education courses are offered.

There is greater recognition of the role of NGOs and civil society organizations, and the need for meaningful community participation in debates and action programmes aimed at education and training for sustainable development. NGOs and governments are increasingly working together, reinforcing each other's strengths and outreach.

Linkages between governmental institutions and NGOs are improving in most countries of the region, and in some cases, governments are actually depending

on mature and experienced NGOs to promote environmental awareness, communication, and training activities.

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International Meets of Environmental Educations

1. Stockholm Conference

Environmental education (EE) gained international recognition in 1972 with the UN Conference on the Human Environment, in Stockholm, Sweden, which called upon environmental education as the means to address environmental issues worldwide. The Conference considered the need for a common outlook and for common principles to inspire and guide the peoples of the world in the preservation and enhancement of the human environment. It proclaimed that:

- Man is both creature and moulder of his environment, which gives him physical sustenance and gives him the opportunity for intellectual, moral, social and spiritual growth. In the long and tortuous evolution of the human race on this planet, a stage has been reached when, through the rapid acceleration of science and technology, man has acquired the power to transform his environment in countless ways and on an unprecedented scale. Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights— the right to life itself.
- The protection and improvement of the human environment is a major issue which affects the well-being of people and economic development throughout the world. It is the urgent desire of the people of the world and the duty of all the governments.
- Man has constantly to sum up experience and go on discovering, inventing, creating and advancing. Man's capability to transform his surroundings, if used wisely, can bring to all people the benefits of development and the opportunity to enhance the quality of life. Wrongly or heedlessly applied, the same power can do incalculable harm to human beings and the human environment. We see around us growing evidence of man-made harm in many regions of the earth: dangerous levels of pollution in water, air, earth and living beings; major and undesirable disturbances to the ecological balance of the biosphere; destruction and depletion of irreplaceable resources; and gross deficiencies, harmful to the physical, mental and social health of man, in the man-made environment, particularly in the living and working environment.
- In the developing countries most of the environmental problems are caused by under-development. Millions continue to live far below the minimum levels required for a decent human existence, deprived of adequate food and clothing, shelter and education, health and sanitation. Therefore, the developing countries must direct their efforts to development, bearing in mind their priorities and the need to safeguard and improve the environment.

For the same purpose, the industrialized countries should make efforts to reduce the gap themselves and the developing countries. In the industrialized countries, environmental problems are generally related to industrialization and technological development.

- The natural growth of population continuously presents problems for the preservation of the environment, and adequate policies and measures should be adopted, as appropriate, to face these problems. Of all things in the world, people are the most precious. It is the people that propel social progress, create social wealth, develop science and technology and, through their hard work, continuously transform the human environment. Along with social progress and the advance of production, science and technology, the capability of man to improve the environment increases with each passing day.
- A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences. Through ignorance or indifference we can do massive and irreversible harm to the earthly environment on which our life and well being depend. Conversely, through fuller knowledge and wiser action, we can achieve for ourselves and our posterity a better life in an environment more in keeping with human needs and hopes. There are broad vistas for the enhancement of environmental quality and the creation of a good life. What is needed is an enthusiastic but calm state of mind and intense but orderly work. For the purpose of attaining freedom in the world of nature, man must use knowledge to build, in collaboration with nature, a better environment. To defend and improve the human environment for present and future generations has become an imperative goal for mankind-a goal to be pursued together with, and in harmony with, the established and fundamental goals of peace and of worldwide economic and social development.
- To achieve this, environmental goal will demand the acceptance of responsibility by citizens and communities and by enterprises and institutions at every level, all sharing equitably in common efforts. Individuals in all walks of life as well as organizations in many fields, by their values and the sum of their actions, will shape the world environment of the future.
- Local and national governments will bear the greatest burden for large-scale environmental policy and action within their jurisdictions. International cooperation is also needed in order to raise resources to support the developing countries in carrying out their responsibilities in this field. A growing class of environmental problems, because they are regional or global in extent or because they affect the common international realm, will require extensive cooperation among nations and action by international organizations in the common interest.

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2. Tbilisi Conference

In 1975, in pursuance of the above recommendation of the United Nations Conference on the Human Environment (Stockholm, 1972) UNESCO and the United Nations Environmental Programme (UNEP) launched the International Environmental Education Programme (IEEP). In 1977 the Intergovernmental Conference on Environmental Education (Tbilisi, USSR), considering that there was a sharply felt need in all countries for international cooperation in this field, called upon UNESCO and UNEP to continue their efforts to further the development of this education within the international community.

Environmental education (EE) is included among the objectives of UNESCO's Medium-Term Plan for 1977-1982, which was approved by the UNESCO General Conference at its nineteenth session (Nairobi, 1976).

The Declaration and Recommendations of the Tbilisi Conference made it possible to define the nature, objectives and pedagogical principles of environmental education and to establish broad guidelines for action in this field at the national and international levels. Since the Tbilisi Conference, the environment has been seen as a whole, simultaneously comprising natural aspects and those that result from human action. Environmental Education is viewed as a dimension of the subject matter and practice of education directed towards the solution of practical environmental problems through an interdisciplinary approach and the active and responsible involvement of each individual and of the community.

The Tbilisi Conference considered that EE should be made an integral part of the entire educational process and aimed at every category of the population such as:

- General public and non-specialists
- Socio-occupational categories whose activities have a significant impact on the environment
- Scientists and technicians whose fields, whether in the natural or the social sciences concern the environment and who need to receive specialized training.

3. The Earth Summit

The Earth Summit in Rio de Janeiro was unprecedented for a UN conference, in terms of both its size and the scope of its concerns. Twenty years after the first global environment conference, the UN sought to help Governments rethink economic development and find ways to halt the destruction of irreplaceable natural resources and pollution of the planet. Hundreds of thousands of people from all walks of life were drawn into the Rio process. They persuaded their leaders to go to Rio and join other nations in making the difficult decisions needed to ensure a healthy planet for generations to come.

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The Summit's message — that nothing less than a transformation of our attitudes and behaviour would bring about the necessary changes — was transmitted by almost 10,000 on-site journalists and heard by millions around the world. The message reflected the complexity of the problems facing us: that poverty as well as excessive consumption by affluent populations place damaging stress on the environment. Governments recognized the need to redirect international and national plans and policies to ensure that all economic decisions fully took into account any environmental impact. And the message has produced results, making eco-efficiency a guiding principle for business and governments alike.

- Patterns of production — particularly the production of toxic components, such as lead in gasoline, or poisonous waste — are being scrutinized in a systematic manner by the UN and Governments alike.
- Alternative sources of energy are being sought to replace the use of fossil fuels which are linked to global climate change.
- New reliance on public transportation systems is being emphasized in order to reduce vehicle emissions, congestion in cities and the health problems caused by polluted air and smog.
- There is much greater awareness of and concern over the growing scarcity of water.

The two-week Earth Summit was the climax of a process, begun in December 1989, of planning, education and negotiations among all Member States of the United Nations, leading to the adoption of 'Agenda 21', a wide-ranging blueprint for action to achieve sustainable development worldwide. At its close, Maurice Strong, the conference secretary-general, called the summit a 'historic moment for humanity'. Although Agenda 21 had been weakened by compromise and negotiation, he said, it was still the most comprehensive and, if implemented, effective programme of action ever sanctioned by the international community. Today, efforts to ensure its proper implementation continue.

The Earth Summit influenced all subsequent UN conferences, which have examined the relationship between human rights, population, social development, women and human settlements — and the need for environmentally sustainable development. The World Conference on Human Rights, held in Vienna in 1993, for example, underscored the right of people to a healthy environment and the right to development, controversial demands that had met with resistance from some Member States until Rio.

Definitions of Environmental Education

'Environmental Education is a way of implementing the goals of environmental protection. It is not a separate branch of science of field of study. It should be carried out according to the principle of life-long integral education.' — Finnish National Commission Education, UNESCO (1976) Seminar at Jammi, 1974.

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According to Mishra (1993), 'Environmental Education appears to be a process that equips human with awareness, knowledge, skill, attitude and commitment to improve environment.'

International working meeting on environmental education in the school curriculum, Paris UNESCO, 1979: 'Environmental Education is the process of recognizing values and clarifying concepts in order to develop skill and attitude necessary to understand and appreciate the interrelatedness among man, his culture and his bio-physical surroundings. It also entails practice in decision making and self formulation of a code of behaviour about problems and issues concerning environmental quality.'

According to Cook and Hearu (1971), 'Environmental education is problem centered, interdisciplinary, value and community oriented, and concerns with man's survival as species, based on student initiated activities and involvements.'

As per R.A. Sharma (1996), 'Environmental education refers to the awareness of physical and cultural environment and perceives its relevance for real life situations. The problems and issues are to be identified. The imbalances of environment are to be improved in view of sustainable development.'

Reviewing all the definitions, environmental education can be summarized as:

- A way to meet the goals of environmental protection.
- A process by which one develops awareness about environment.

Environment Education is significant because of the following reasons:

- Comprises of a learning process that increases people's knowledge and awareness about associated challenges
- Develops the necessary skills and expertise to face challenges
- Facilitates better attitude, motivations and commitments to take responsible action
- Enhances critical thinking, problem solving and effective decision-making skills
- Enables individuals to calculate various sides of environmental issues
- Encourages inquiry and investigation
- Ensures literate individuals to make healthy citizen and community
- Improves everyday life by protecting human health
- Encourages expansion of natural resources
- Establishes ecological equilibrium which explains proper use and conservation of resources
- Controls environment pollution
- Understands the importance of balanced environment and remedial measures for checking the imbalances of environment

Apart from this, some more objectives of environmental education have been chalked out by various international seminars and conferences.

- 'To create an awareness and an understanding of the evolving social and physical environment as a whole, its natural, manmade, cultural, spiritual resources, together with the rational use and conservation of these resources for development.' – Report of a conference of African educators, EDC and CREDO, Nairobi, African Social Studies programmes, 1968.
- 'In order to enable people to enjoy good health and a high quality of life, it is vital to prevent harmful effects to human health or damage to the environment caused by pollution of air, water, and soil, noise, vibration, noxious, smells, etc., caused by firms and individuals. The environment includes animals and plants and their ecological systems which are closely bound to the livelihood of people.' – National Anti Pollution Law, Japan, 1968.
- Environmental Education is an integral part of the education process. It should be centered on practical problems and be interdisciplinary in character. It should be aimed at building up a sense of values, contribute to public well being and concern itself with the survival of the human species. Its force should reside mainly in the initiative of the learners and their involvement in action and it should be guided by both immediate and future subjects of concern – Final report of the Tbilisi Conference, 1977.

Nature and scope of Environmental Education

The following points summarize the nature of the Environmental Education.

- Action against real problems
- Interdisciplinary in nature
- Solution for environmental situations and problems
- Modification of values in relation to environment
- Development of skills and attitude
- A continuous process
- An educational experience which provides solution for environmental problems
- Newly created field for all socio-professional groups
- Vital to prevent harmful effects to human health
- Relationship between man, its culture and biophysical environment
- Decision-making practice
- Self-formulation of a code of behaviour

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- Not a separate branch of science
- An integral part of the educational process
- Formal as well as informal
- For all age groups
- A style and subject matter of education

Scope of Environmental Education

Environmental education is the need of the day. It is a part of education for society in the developed, developing and least developed countries. It strives to improve things through environment, about environment and for environment.

The scope of environmental education is designed under two categories:

(i) Scope in terms of subjects

(ii) Scope in terms of environmental issues and subject matter

According to Tbilisi conference, an environmental study as a subject has immense opportunity. It includes a variety of subjects and arenas which can be listed as:

- Maintenance and protection of natural resources
- Natural science and biodiversity
- Management and reduction of environmental pollution
- Community related issues with respect to development and environment
- Human population and environment

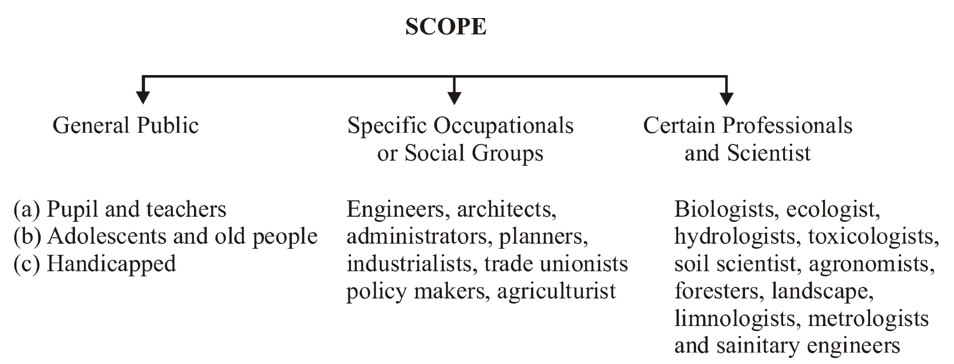


Fig 7.1 *Scope of Environmental Education for Different Categories of Individuals*

These are the fundamental characteristics of environmental education which have an immediate influence on society. Environmental Studies are also at times, highly focused on more technological features like environmental science, environmental engineering or environmental management.

In modern times, the range of environmental studies has increased significantly. A number of career opportunities have become known in these fields that are largely classified as:

(i) Research and Development (R&D) in Environment: Proficient environmental scientists play a significant role in investigating numerous environmental problems in a scientific manner. In this manner, they are able to perform R & D activities for developing cleaner technologies and ensuring that the present development is able to meet the needs of the current generation without compromising on the needs of the future generations. Environmental management and environmental engineering are emerging as new career opportunities for environmental protection and management. In India the pollution control boards (PCB) are taking stringent action to execute pollution control laws.

(ii) Green Advocacy: Environment Studies as a subject now needs to have advocates since several Acts and Laws related to environment have been implemented. Advocates will need to fight for cases related to water and air pollution, forests and wildlife.

(iii) Green Marketing: We now find products in the market which have ISO 14001 Certification. This certification implies that the products are environment friendly and will not adversely affect the environment. As a result, environmental auditors and environmental managers are the emerging career opportunities in the coming years.

(iv) Green Media: In the age of technology, awareness about the environment can be easily spread not only by television, radio, newspapers but also through the Internet, magazines, hoardings and advertisements.

(v) Environment Consultancy: A lot of non-government organizations (NGOs), corporate bodies and government organizations are hiring the services of environmental professionals for thoroughly studying and confronting environment related problems.

Universal vs Local Nature of Environment

Environment is one focus that is both global and local in nature. Issues like global warming, diminution of ozone layer, declining forests and energy resources, loss of diverse plants and animals at the global level are some of the problems which are going to have a direct and indirect influence on human beings at the global level.

However, there are some environmental problems which have to be handled at the local level. For example, impact of mining, or hydroelectric project in an area, difficulty in disposal and management of solid waste, pollution of water bodies, soil erosion, water logging, and salinization of soil, and arsenic pollution of ground water have to be handled at the local level.

Individualistic Nature of Environment

Environmental studies is an indispensable subject matter. It deals with the most commonplace problems of life which concern every human being such as provision

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of safe and clean drinking water, clean living conditions, fresh air, fertile land, healthy food and sustainable development. If we want to lead a healthy life, live long with less number of health problems and preserve the same for the future generations, it is most essential to understand the basics of environment.

Sustainable development requires public-private partnership. However, the public can be encouraged to participate only when they are made conscious about the environmental issues.

All individuals should be made conscious of their duty to keep the environment neat and clean. This will ensure that the environment is conserved and preserved for a better tomorrow.

Check Your Progress

1. What was the Earth Summit message?
2. Define environmental education.
3. Name the categories under which the scope of environmental education is designed.

7.3 FORMAL AND INFORMAL EDUCATION IN INDIA

Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions. In other words, environmental education is a study of nature. It helps us explore the problems which environment faces and also in spreading the awareness about the causes of such problems. A profound understanding of the environment will help us tackle these issues efficiently. Meanwhile, building strategies to enhance and sustain nature is also part of environmental education. It creates a positive impact on youth. Environmental education helps us become conscious of our actions. Similarly, this further assists us in making responsible choices.

Constituents of Environmental Education

1. Awareness: It makes us aware of the functioning of our environment. In addition, it also throws light on environmental issues.
2. Empathy: Environmental education makes us empathetic towards such problems. It gives us a deeper understanding.
3. Approach: How humans should approach the challenges is taught by Environmental Education. It encourages a thoughtful approach to sustain the environment.

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4. Aid: It assists us in classifying environmental issues. Moreover, it gives us the ability to resolve them.
5. Contribution: Environmental education motivates us to contribute our bit for a greater cause. Above all, it inspires us to partake in bringing about a change.

Advantages of Environmental Education

Given below are the advantages of environmental education:

1. Encourages kids to respect mother earth and its animals: By teaching kids how to respect our nature, we will pave way for a brighter future. Environmental Education teaches us to be kind towards animals. This will have a positive impact on our nature.
2. Cultivates critical thinking: In addition to making kids respectful of nature, it also develops critical thinking in them. They become mindful of their actions and their magnitudes. Therefore, good habits are instilled in kids, which will influence our nature in a positive manner.
3. Promotes a healthy way of life: Nowadays when everyone is glued to their phones, people hardly move their muscles. Environmental education encourages kids to participate in outdoor activities. It teaches us about the benefits of the environment and how we can use it to our advantage.
4. Environmental balance is restored: By teaching kids how their actions impact nature, we can maintain environmental balance. For instance, if someone is cutting down a tree in one corner, in the other corner a kid is learning to plant one. It helps in creating a sustainable future.
5. Gives a much-needed break from monotony: The mundane routine of studying theoretical subjects is tiring. Environmental Education gives the kids a chance to engage in activities outside the class. It makes them active and lively. Environmental education serves as a fun break for students.

In conclusion, environmental education is the need of the hour. Thousands of animals and forests are dying due to human activities. Steps must be taken to preserve our mother earth. Today's world is going through a climatic crisis. Environmental Education can bring much-needed change. When we teach kids early about the importance of the environment, we pave way for a healthier and greener environment.

Environmental education in India

Environmental education in India is imparted through formal and informal ways. We will study about these two methods here.

(a) Formal Education: Formal education is given in schools, colleges and universities, for a limited period of time. It has a well-defined and systematic curriculum. The best methodology in any mindfulness program is to

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proliferate through children and youth as they rapidly take to groundbreaking thoughts and are the future activists. Formal environmental education should start at the school level.

Curriculum ought to be built considering the class and age of the students. They should be made understand about the environmental issues effectively and the emphasis ought to be on developing the ecological awareness in kids. In lower grades, kids are conscious about the physical and social aspects of climate. At this stage and after it, inter-disciplinary methodology should be used and the stress should be on expanding the knowledge about ecological issues and preservation of environment.

The mode of giving environmental education is not just through books but also through practical experiences in field activities and eco-development camps. The exercises in environmental education system can be different depending upon the environmental conditions of a place.

The National Council of Educational Research and Training (NCERT) has developed an educational program system on the basis of which, many books, reading material and teaching aids have been prepared. University Grants Commission (UGC) is vested with the responsibility of environmental education at postgraduate level.

Usually, environment subject is taught under the biology course in colleges but in many engineering colleges it is taught as environmental engineering. Subjects like civil engineering, environment im-provement of urban slums, town and country planning, human settlements, landscaping, industrial design, designing environmental friendly technologies and environmental impact assessment for sustainable development are included in Environmental Engineering.

Environment education incorporates subjects like land-use, horticulture, waste management, conservation of natural resources, forestry, national parks, water resources management, biosphere reserves, etc. Moreover, subjects like cleanliness, toxicology, word related wellbeing, sustenance, etc., are also included under the studies.

At postgraduate level, environmental education training incorporates social nature for example human environment, social science, brain research, cost-benefit aspect and environmental ethics.

Case studies must be designed at known areas as dissertation and field work reports and research must be carried out on certain environmental issues related to the local environment. Environmental legislation is also a part of the course and it includes environmental policies and environmental protection laws.

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Current Situation of Formal Environmental Education in India

There are about 200 departments of environmental studies in various Indian universities and colleges. They offer degree or diploma courses that cover all aspects of environmental sciences and engineering. Diplomas, bachelor's degree, M.Sc, M.Phil and Ph.D programmes are also there in environ-mental sciences. Moreover, M.E., M.Tech and Ph.D programmes in environmental engineering are offered by Civil Engineering and Chemical Engineering departments.

Post graduate degree programmes in environmental management and other courses related to environmental studies, which lead to M.Sc in environmental chemistry/biology/geology or environmental toxicology, are also available.

Environmental education at Ph.D level is also offered by autonomous Research and Development (R & D) institutions set up by central government, state governments and other agen-cies such as CSIR, ICAR and ICMR. It can be inferred that formal education in environmental sci-ence or engineering is available in India up to the highest possible level.

There is a necessity of restructuring of environmental studies programmes in order to produce instead of generalists, professionals whose expertise is in Environmental Botany or Environmental Zoology/Chemistry/Economics/ Sociology etc.

These courses ought to have relatively specific curricula having provisions for training students in specialisations such as forest ecology, Limnology, marine ecology, environmental analysis, pollution studies, environmental toxicology, etc.

(b) Informal Education: For a majority of the people that still have no access to formal education, environmental education can be gained by pursuing courses that fall outside the ambit of the formal education system. Environmental education should be a lifelong learning and not just limited to a particular course for a specific period of time in an institution.

This acknowledgment has resulted in an increase in non-formal education which includes practices outside the domain of the pre-defined formal education system. The process of non-formal environment education is sort of an experiential and project-based learning that involves exercises of finding solutions of environmental problems.

This provides the students an opportunity for out-of-school exposure. It helps them in acquiring the skills related to natural processes of enquiring, exploring, conjecturing, comparing, inferring, evaluating and decision making regarding environmental issues in their locality. The most fundamental characteristic of non-formal environmental education programmes is the flexibility of approach.

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Eco-development drives and camps aim at spreading awareness about basic ecological prin-ciples and addressing environmental issues after recognising the causes of the ecological problems. Activities like tree plantation, trenching, fencing, seed-banks, cleaning water-bodies, hygiene and promoting the use of non-conventional energy are included in these eco-development drives and camps.

The Vikram Sarabhai Community Centre, Ahmedabad, includes kids in completing experiments and surveys, and, the Centre for Environmental Education has created a water monitoring kit for school students under the Ganga Pollution Control Program. Numerous institutions like Bal Bhawan Society, Shantiniketan, etc., use methods such as arts and crafts, dance and street plays to give informal environmental education to the students.

Check Your Progress

4. How does environmental education promote a healthy way of life?
5. How does informal environmental education help the student?

7.4 ORGANIZATION FOR ENVIRONMENTAL PROTECTION

There are many international agencies set up to protect environment in various conferences. These are playing a vital role in this direction.

United Nations Environment Program (UNEP)

Set up in 1972, after the Stockholm Conference, the United Nations Environment Program (UNEP) is the principal body of the UN in the field of environmental protection. It reviews the state of the global environment, facilitates the progression of international environmental law and coordinates the activities of the United Nations.

The UNEP plays a significant role in facilitating global negotiations on MEAs and also acts as a secretariat to a number of MEAs. It also organizes an annual Global Ministerial Environment Forum, wherein environmental ministers from around the world meet to discuss the issues of contemporary interest.

The UN Commission on Sustainable Development (CSD)

The UN Commission on Sustainable Development (CSD) was set up in 1992 as a follow-up mechanism to the Earth Summit. It is a functional commission of the economic and social council (ECOSOC) and is composed of 53 members elected for three year terms by the ECOSOC from amongst the UN members. The CSD acts as a catalyst for actions that support the objectives of sustainable development. Its mandate is to monitor and report on the implementation of the Earth Summit

agreements such as Agenda 21 and the Rio Declaration at the local, national, regional and international levels.

After the World Summit on Sustainable Development in 2002, the CSD now monitors the follow up of the Johannesburg Plan of implementation. It meets annually for a period of two to three weeks in order to address the issues relating to sustainable development. The relationship between UNEP and CSD has not always been clear, although their mandates are clearly different.

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Global Environment Facility (GEF)

The GEF is an international funding mechanism that was set up in 1991 to facilitate environmental protection in the developing countries by funding projects and programs in these countries. The GEF addresses six environmental problems that have been identified as critical for the global environment—loss of biodiversity, climate change, ozone layer, depletion, degradation of international waters, desertification and persistent organic pollutants (POPs). The GEF is the designated financial mechanism for the Convention on Biological Diversity, 1992 and the UN Framework Convention on Climate Change, 1992.

The GEF has given $4 billion in grants and generated $12 billion in co-financing with other sources to support over 1000 projects in over 140 developing countries. In 2002–03, a replenishment of $2.9 billion was agreed upon. The United Nations Developing Program (UNDP), the United Nation Environment Program (UNEP) and the World Bank are the Implementing agencies of the GEF, i.e., manage the actual implementation of the projects. The GEF secretariat operates from Washington D.C. The participating states meet at the GEF assembly every 3–4 years to assess the progress of the GEF projects.

There are also many other institutions working for environment protection like the Intergovernmental Panel on Climate Change, International Plant Protection Convention, World Environment Organization, Codex Alimentaries and other indirect agencies playing a suportive role in environment area like the IMF, World Bank and other NGOs.

Check Your Progress

6. What is the work of the United Nations Environment Program (UNEP)?
7. Which six environmental problems are addressed by the GEF?

7.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The Earth Summit's message was that nothing less than a transformation of our attitudes and behaviour would bring about the necessary changes.
2. 'Environmental Education is a way of implementing the goals of environmental protection. It is not a separate branch of science of field of study. It should

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be carried out according to the principle of life-long integral education.' — Finnish National Commission Education, UNESCO (1976) Seminar at Jammi, 1974.

3. The scope of environmental education is designed under two categories:
   (i) Scope in terms of subjects
   (ii) Scope in terms of environmental issues and subject matter
4. Environmental education encourages kids to participate in outdoor activities. It teaches us about the benefits of the environment and how we can use it to our advantage.
5. Informal environmental education helps the students in acquiring the skills related to natural processes of enquiring, exploring, conjecturing, comparing, inferring, evaluating and decision making regarding environmental issues in their locality.
6. The United Nations Environment Program (UNEP) reviews the state of the global environment, facilitates the progression of international environmental law and coordinates the activities of the United Nations.
7. The GEF addresses six environmental problems that have been identified as critical for the global environment—loss of biodiversity, climate change, ozone layer, depletion, degradation of international waters, desertification and persistent organic pollutants (POPs).

7.6 SUMMARY

- Environmental education is an important segment within the educational system. In many countries government supported programmes are constituted which are pursued by social groups, scientific community and educational institutions.
- Awareness and understanding of environmental issues provide the basis and rationale for commitment and meaningful action towards environmentally sound and sustainable development.
- The key international conventions on environment place a high value on public awareness, education and training and obtaining information through monitoring as essential elements for the success of the conventions.
- Environmental education (EE) gained international recognition in 1972 with the UN Conference on the Human Environment, in Stockholm, Sweden, which called upon environmental education as the means to address environmental issues worldwide.
- The Declaration and Recommendations of the Tbilisi Conference made it possible to define the nature, objectives and pedagogical principles of environmental education and to establish broad guidelines for action in this field at the national and international levels.

- The Earth Summit's message reflected the complexity of the problems facing us: that poverty as well as excessive consumption by affluent populations place damaging stress on the environment.
- The Earth Summit influenced all subsequent UN conferences, which have examined the relationship between human rights, population, social development, women and human settlements — and the need for environmentally sustainable development.
- Environmental education is the need of the day. It is a part of education for society in the developed, developing and least developed countries. It strives to improve things through environment, about environment and for environment.
- The scope of environmental education is designed under two categories:
  - (i) Scope in terms of subjects
  - (ii) Scope in terms of environmental issues and subject matter
- Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions.
- Environmental education in India is imparted through formal and informal ways.
- Formal education is given in schools, colleges and universities, for a limited period of time. It has a well-defined and systematic curriculum.
- For a majority of the people that still have no access to formal education, environmental education can be gained by pursuing courses that fall outside the ambit of the formal education system.
- Set up in 1972, after the Stockholm Conference, the United Nations Environment Program (UNEP) is the principal body of the UN in the field of environmental protection.
- The GEF is an international funding mechanism that was set up in 1991 to facilitate environmental protection in the developing countries by funding projects and programs in these countries.

7.7 KEY WORDS

- **Environmental education:** It refers to organized efforts to teach how natural environments function, and particularly, how human beings can manage behavior and ecosystems to live sustainably.
- **Agenda 21:** It is a non-binding action plan of the United Nations with regard to sustainable development. It is a product of the Earth Summit held in Rio de Janeiro, Brazil, in 1992.

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- **Sustainable development:** It is the organizing principle for meeting human development goals while simultaneously sustaining the ability of natural systems to provide the natural resources and ecosystem services on which the economy and society depend.

7.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the main objectives of environmental education programmes?
2. List the categories of the population which the Tbilisi Conference considered for making EE an integral part of.
3. What are the constituents of environmental education?
4. What is the purpose of eco-development drives and camps?

Long-Answer Questions

1. Explain why Environment Education is significant.
2. Describe the objectives of environmental education that have been chalked out by various international seminars and conferences.
3. Discuss the scope of environmental education in today's world.
4. Evaluate the nature of environmental education.
5. Describe the advantages of environmental education.
6. Write an essay on the 'Environmental education in India'.

7.9 FURTHER READINGS

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UNIT 8 UNEP AND EARTH SUMMIT

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Structure

8.0 INTRODUCTION

An international environmental agreement, or sometimes an environmental protocol, is a type of international law-binding treaty that helps them to accomplish an environmental objective. A two-nation agreement is regarded as a bilateral environmental agreement. If the agreement is signed among three or more countries, this is referred to as a multilateral environmental agreement (MEA). Topics such as atmospheric policies, freshwater policies, hazardous waste and material policies, the aquatic environment, conservation policies, noise pollution and nuclear safety are protected by such agreements, mostly developed by the United Nations. In this unit, we will discuss the objectives of UNEP or United Nations Environment Programme, along with the Earth Summit of 1992. We will also focus on other significant international conferences and agreements on environment.

8.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the significant international conferences and agreements on environment
- Explain the objectives of UNEP or United Nations Environment Programme
- Discuss the significance of Earth Summit of 1992

8.2 INTERNATIONAL CONFERENCES AND AGREEMENTS ON ENVIRONMENT

Let us begin with one of the first global treaties on the environment.

8.2.1 Antarctic Treaty

Antarctica is deeply covered with ice with an average thickness of about 1800 metres. With increase in distance from the sea, the thickness of the ice increases and reaches up to about 4200 metres. The ice in this continent constitutes about 90 per cent of the world's fresh water reserve. The ice gradually moves outwards from the centre in the form of glaciers such as Lambort and Blardnoce glaciers. After reaching the plateau edge, the large masses of ice break off forming icebergs, also known as Ice Mountains; which are about 20–60 metres in height and from a few hundred metres to about 50 km in length.

Antarctica, the vast plateau-continent, along with many scattered groups of islands, has an area of about 14 million sq. km. It is assumed that Antarctica initially was a part of a single great landmass called Gondwanaland which also included Australia, South Africa, South America and the Indian subcontinent. About 200 million years ago, Gondwanaland began to break up and all the parts got scattered. Antarctica has an extremely long (about 30,000 km) coastline and is about 2000–2400 metres high. Since the continent is highly elevated, it is also known as the highest continent. Antarctica is the driest, windiest and coldest of all the continents. It is almost always in fruition state and air is always very dry. Wind reaches here roughly at a speed of about 200 km per hour and frequent blizzards occur in autumn and winter. The average temperature nearer to the coast varies between 273K and 262K while the interior plateau has an average temperature of about 185K. In winter, the land remains in darkness and in summer the sun bathes the continent with the oblique rays during the daytime.

There are no living creatures including plants or trees in the interior of the Antarctica. Mosses and lichens in small numbers are found only in the coastal areas during the short summers. Small fishes, seeds and whales are found in the sea around the continent. There are birds like gulls, terns, petrels and the flightless penguins which live in rookeries in the coastal areas. Nature abounds in krills which are the prey of seals and whales. The krills, on the other hand, survive on microscopic plants called diatoms. The continent is a storehouse of minerals. It is a vast reserve of off-shore oil and natural gas, coal, copper, gold, etc.

Different parts of Antarctica were claimed by seven countries, namely Argentina, Chile, France, United Kingdom, Norway, Australia and New Zealand. However, the Antarctic Treaty signed in 1959 froze all political claims. The Treaty which came into force in June 1961 granted that the continent would only be used for peaceful purposes. The later treaties, such as the Madrid Agreement in 1991,

and the Protocol on Environmental Protection in 1998, strengthened the Antarctic Treaty further and imposed a ban on exploitation, prohibited future territorial claims and preserved it only for non-military scientific research for all the countries in the world and declared the continent as a 'natural reserve'. There are about thirty-six odd permanent research stations in the Antarctica and the United States station on the Sofs Island can be termed as a town and has the only Jet airport of the continent. The population here is only that of the scientists of different scientific stations numbering 900 in winter, which rises to about 11,000 in summer due to arrival of tourists and personnel in the summer research sites. India has set up two manned research stations on Queen Maud in north-east Antarctica after her first expedition in 1982. The two research stations are Dakshin Gangotri and Maitri. The fourteen short articles of the treaty are summarized by Martin Glannere and can be given as follows:

> Antarctica is to be used for peaceful purposes only; no military activities of any kind are permitted, though military personnel and equipment may be used for scientific purposes. Freedom of scientific investigation and cooperation shall continue and results of investigation shall be freely exchanged. No prior territorial claim is recognized, disputed or established and no new claims may be made while the Treaty is in force. Nuclear explosions and disposing of radioactive wastes are prohibited.

8.2.2 The Basel Convention on Minimizing Hazardous Wastes

Industrialization has brought about modernization of lifestyle and its associated benefits. Health-giving medicines, labour-saving household appliances, automobiles and ships, paints and detergents, synthetic fibres and polythene packaging, personal computers and TVs—the list of useful manufactured goods is almost endless. But with the goods come the bad effects. Industrial production results in hundreds of millions of tonnes of wastes every year. These wastes include chemical by-products that are hazardous to human health and the environment because they are poisonous, eco-toxic, explosive, corrosive, flammable, or infectious. Too often these wastes pour out of smokestacks and outtake pipes or lie abandoned in dumps or leaky storage drums. Sometimes wastes are shipped off illegally to faraway places, exposing unsuspecting communities to terrible dangers. The cross-border transport of hazardous wastes caught the public attention in the late 1980s. The misadventures of 'toxic ships', such as the Karin B and the Pelicano, sailing from port to port trying to offload their poisonous cargoes, made front page headlines around the world. These tragic incidents were motivated in good part by tighter environmental regulations in the industrialized countries. As the costs of waste disposal skyrocketed, 'toxic traders' searching for cheaper solutions started shipping hazardous wastes to eastern Europe and Africa and other regions.

Once on shore, unwanted shipments are typically dumped indiscriminately, spilled accidentally or managed improperly, causing severe health problems—even death—and poisoning the land, water and air for decades or centuries. These criminal shipments must be stopped and their perpetrators brought to justice. But

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toxic ships are just a symptom of a much more fundamental problem. If the production of goods did not generate so much hazardous waste, if this waste were not so dangerous, if wealthier communities did not resist new treatment plants and dumps, and if the costs of detoxifying wastes were not so astronomical, there would be less financial incentive to cheat and dump wastes illegally.

Recognizing the gravity of the problem and understanding that the industrial society must fix this major flaw in their system, governments and many forward-looking companies started exploring solutions as early as the 1970s. By the 1980s, the international community launched treaty negotiations under the auspices of the United Nations Environment Programme. In March 1989, they adopted the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The treaty entered into force in 1992 and now boasts over 160 parties.

Drawing on the principles of environmentally sound management (ESM), the Convention seeks to protect human health and the environment from the dangers posed by hazardous wastes. This will require changing the economic equation for wastes in order to motivate the producers of hazardous wastes and people who benefit from the associated goods to take action. To do this, the Convention sets out a three-step strategy, the steps are as follows:

- Minimize the generation of wastes
- Treat wastes as near as possible to where they are generated
- Reduce international movements of hazardous wastes

At the seventh meeting of the Conference of the Parties to the Basel Convention, the parties shared concerns regarding the unprecedented increase in the hazardous wastes and the challenges to manage these wastes in an environmentally sound manner. As a consequence, the parties adopted the Ministerial Statement on Partnerships for Meeting the Global Waste Challenge, which builds upon the Basel Declaration and the Strategic Plan of the Basel Convention. The statement sets four priority policy directions for the future: (i) the regional approach, (ii) waste minimization, (iii) integrated waste management, and (iv) the life cycle approach. The ultimate goal of activities resulting from this statement is to make the environmentally sound management of hazardous wastes and other wastes a reality on the ground. However, much more needs to be done. The development and transfer of cleaner technologies and processes must be accelerated. Without a dramatic increase in such technologies in the next ten to twenty years, the generation of hazardous wastes by an expanding global economy could reach unmanageable dimensions. Only by giving the issue a higher profile on the international agenda can governments ensure that action under the Basel Convention will lead to an environmentally sustainable future free from the dangers of hazardous wastes.

8.2.3 Stockholm Conference

The UN conference on Human Environment was organized with the initiative of the Government of Sweden, which was held in Stockholm. The conference was attended by around 113 countries across the world. This episode was widely recognized as the beginning of modern political and public awareness of global environmental issues. Nonetheless, the conference discussed the problem of relationship between development and environmental degradation peripherally. A general framework was provided for conservation of human environment, by the Stockholm conference. The Stockholm conference adopted the following three non-binding instruments:

- A resolution on institutional and financial arrangement
- A declaration containing 26 principles
- An action plan containing 109 recommendations

These three non-binding instruments prepared the final stage of negotiations on the environment. However, the most important contribution of the Stockholm conference was the development of a set of principles that formed the backdrop of all subsequent international negotiations on the environment. As per example, the principle 24 of its declaration calls for international cooperation to effectively control, prevent, cut down and eliminate adverse environmental impact in such a way, so that it does not compromise the sovereignty of an individual state. All states shall ensure that their activities pertaining to jurisdiction shall not cause any further damage to other states. Environmental protection to human rights as the norm is stated in Principle 1.

International negotiations on environmental protection were further motivated regarding environmental issues. The principles stated were refined in the next international conference on environment in Rio-de-Janeiro, Brazil in 1992. The declaration of the Stockholm conference (1972) contained the following principles:

- Human rights must be asserted, apartheid and colonialism must be condemned.
- Natural resources must be safeguarded.
- The earth's capacity to produce renewable resources must be maintained.
- Wildlife must be safeguarded.
- Non-renewable resources must be shared and not exhausted.
- Pollution must not exceed the environment's capacity to clean itself.
- Damaging oceanic pollution must be prevented.
- Development is needed to improve the environment.
- Developing oceanic pollution must be prevented.
- Developing countries need reasonable prices for exports to carry out environmental management.

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- The environment policy must not hamper development.
- Developing countries need money to develop environmental safeguards.
- Integrated development planning is needed.
- Rational planning should resolve conflicts between the environment and development.
- Human settlement must be planned to eliminate environmental problems.
- Governments should plan their own appropriate population policies.
- National institutions must plan development of states' natural resources.
- Science and technology must be used to improve the environment.
- Environment education is essential.
- Environmental research must be promoted, particularly in developing countries.
- States may exploit their resources as they wish but must not endanger others' resources.
- Compensation due to states thus endangered.
- Each nation must establish its own standards.
- There must be cooperation on international issues.
- International organizations should help improve the environment.
- Weapons of mass destruction must be eliminated.

Some of the important recommendations made by the Stockholm conference are as follows:

- Preparing short-term and long-term plans at regional, sub-regional and sectoral levels for the study and identification of the countries of the region concerned as well as the special problems of the least developed countries of the region and of countries with coastlines and inland lakes and rivers exposed to the risk of marine and other forms of pollution.
- Evaluating the administrative, technical and legal solutions of various environmental problems in terms of both preventive and remedial measures, taking into account possible alternatives and or multi-disciplinary approaches to development.
- Preparation, within the framework of international agreements, of legislative measures designed to protect marine and fresh water fisheries resources within the limits of the national jurisdiction.

There are also many other important international conventions on environment including Convention on International Trade in Endangered Species of Wild Founa and Flora (CITES) 1973, Kyoto protocol, Rotterdam convention, etc. In this unit, let's focus on UNEP and Earth summit.

Check Your Progress

1. Which is the driest, windiest and coldest of all continents?
2. When was the Stockholm Conference held?

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8.3 UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

The United Nations Environment Programme (UNEP) is the leading environmental authority in the United Nations system. UNEP uses its expertise to strengthen environmental standards and practices while helping implement environmental obligations at the country, regional and global levels. UNEP's mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP re-organised its work programme into six strategic areas as part of its move to results based management. The selection of six areas of concentration was guided by scientific evidence, the UNEP mandate and priorities emerging from global and regional forums.

- **Climate change:** UNEP strengthens the ability of countries to integrate climate change responses by providing leadership in adaptation, mitigation, technology and finance. UNEP is focusing on facilitating the transition to low-carbon societies, improving the understanding of climate science, facilitating the development of renewable energy and raising public awareness.
- **Post-Conflict and disaster management:** UNEP conducts environmental assessments in crisis-affected countries and provides guidance for implementing legislative and institutional frameworks for improved environmental management. Activities undertaken by UNEP's Post-Conflict & Disaster Management Branch (PCDMB) include post-conflict environmental assessment in Afghanistan, Côte d'Ivoire, Lebanon, Nigeria and Sudan.
- **Ecosystem management:** Facilitates management and restoration of ecosystems in a manner consistent with sustainable development, and promotes use of ecosystem services. Examples include the Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities.
- **Environmental governance:** UNEP supports governments in establishing, implementing and strengthening the necessary processes, institutions, laws, policies and programs to achieve sustainable

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development at the country, regional and global levels, and mainstreaming environment in development planning.

- **Harmful substances:** UNEP strives to minimise the impact of harmful substances and hazardous waste on the environment and human beings. UNEP has launched negotiations for a global agreement on mercury, and implements projects on mercury and the Strategic Approach to International Chemicals Management (SAICM) to reduce risks to human health and the environment.
- **Resource efficiency/sustainable consumption and production:** UNEP focuses on regional and global efforts to ensure natural resources are produced, processed and consumed in a more environmentally friendly way. For example, the Marrakesh Process is a global strategy to support the elaboration of a 10-Year Framework of Programs on sustainable consumption and production.

8.4 EARTH SUMMIT OF 1992

The United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', was held in Rio de Janeiro, Brazil, from 3-14 June 1992. This global conference, held on the occasion of the 20th anniversary of the first Human Environment Conference in Stockholm, Sweden, in 1972, brought together political leaders, diplomats, scientists, representatives of the media and non-governmental organizations (NGOs) from 179 countries for a massive effort to focus on the impact of human socio-economic activities on the environment. A 'Global Forum' of NGOs was also held in Rio de Janeiro at the same time, bringing together an unprecedented number of NGO representatives, who presented their own vision of the world's future in relation to the environment and socio-economic development.

The Rio de Janeiro conference highlighted how different social, economic and environmental factors are interdependent and evolve together, and how success in one sector requires action in other sectors to be sustained over time. The primary objective of the Rio 'Earth Summit' was to produce a broad agenda and a new blueprint for international action on environmental and development issues that would help guide international cooperation and development policy in the twenty-first century.

The 'Earth Summit' concluded that the concept of sustainable development was an attainable goal for all the people of the world, regardless of whether they were at the local, national, regional or international level. It also recognized that integrating and balancing economic, social and environmental concerns in meeting our needs is vital for sustaining human life on the planet and that such an integrated approach is possible. The conference also recognized that integrating and balancing economic, social and environmental dimensions required new perceptions of the

way we produce and consume, the way we live and work, and the way we make decisions. This concept was revolutionary for its time, and it sparked a lively debate within governments and between governments and their citizens on how to ensure sustainability for development.

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One of the major results of the UNCED Conference was Agenda 21, a daring program of action calling for new strategies to invest in the future to achieve overall sustainable development in the 21st century. Its recommendations ranged from new methods of education, to new ways of preserving natural resources and new ways of participating in a sustainable economy. The 'Earth Summit' had many great achievements: the Rio Declaration and its 27 universal principles, the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity; and the Declaration on the principles of forest management. The 'Earth Summit' also led to the creation of the Commission on Sustainable Development, the holding of first world conference on the sustainable development of small island developing States in 1994, and negotiations for the establishment of the agreement on straddling stocks and highly migratory fish stocks.

8.4.1 Agenda 21

In 1992, the United Nations Conference on Environment and Development (UNCED), held at Rio de Janeiro, adopted a declaration and a global agenda for management of the environment in the next century. The declaration is known as Agenda 21, which is a massive 800-page document. It contains the Action Programme for attaining sustainable development. It also classifies several important concepts of environmental management that have immediate relevance for the marine environment.

Agenda 21 lays down 115 specific programmes. It is a key document but not binding. Its recommendations are classified into different areas such as:

- Socio-economic issues to protect and promote human health;
- Conservation and management of resources such as combating deforestation, desertification and drought;
- Promotion of sustainable agriculture and rural development;
- Strengthening of networks consisting of women, NGOs, business, scientific and technological community, farmers through financial resources,
- Transfer of environment-friendly technology,
- Training,
- International legal instruments and mechanisms.

At present, there is no binding international charter which contains general principles of international environmental law. During the preparations for UNCED, attempts were made to draft an earth charter which would have served this purpose.

However, no agreement could be reached on the desirability of such an approach. Nevertheless, now there is an abundance of environmental instruments related to environmental issues, and it is possible to identify a number of basic principles on which these instruments are invariably based. Some of these principles, which we have already described above, are:

- The polluter pays principle
- The principle of non-discrimination
- The precautionary principle
- The principle of common but differentiated responsibility
- The principle of intergenerational equity

Most of these principles are reflected in the Rio Declaration on environment and development. A brief account of these principles is given Table 8.1.

Table 8.1 *Basic Principles underlying International Instruments*

Principle	Description
The polluter pays principle	The polluter should bear the expenses of carrying out anti-pollution measures decided by the public authorities. The costs of these measures should thus be reflected in the costs of goods and services which cause pollution.
Principle of non-discrimination	Polluters causing trans-boundary pollution should be treated no less severely than they would be if they caused similar pollution within their own country.
Precautionary principle	Lack of full scientific certainty shall not be used as a reason for postponing measures to prevent environmental degradation.
Principle of common but differentiated responsibilities	States should divide the costs of measures to protect the environment on the basis of the fact that they have made different contributions to global environmental degradation.
Principle of intergenerational equity	States are obliged to take into account the long-term effects of their actions affecting the environment. This principle attempts to emphasize that attention should not only be paid to long-distance effects but also to the long-term effects of human activity.

8.4.2 Convention on Biological Diversity

Biological diversity is the variety and variability among living organisms and the ecological complexes in which they occur. The Convention on Biological Diversity (CBD) is an international treaty adopted in Rio de Janeiro, Brazil in June 1992 with the following three main objectives: (i) Conservation of biodiversity (ii) Sustainable use of the components arising from it, and (iii) Sharing of benefits of genetic resources in a fair and equitable way.

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The Convention was signed at the Earth Summit in Rio de Janeiro on 5 June 1992 by 154 countries and entered into force on 29 December 1993. It is understood that biological diversity (the ecosystem, species and genes) is 'a common concern of human kind' and is an integral part of the developing process. The Convention links traditional conservation efforts to the economic goal of using biological resources in a sustainable manner. The Convention also deals with the 'Cartagena protocol on biosafety'.

It reminds the decision-makers (governments, private organizations) that natural resources are not infinite and can be exploited for the benefits of human at a rate that does not lead to the long-term decline of biodiversity. Substantial investments are therefore required to conserve biodiversity and which in turn will bring about substantial environmental, economic and social benefits.

Issues dealt with in the convention

Some of the issues dealt with in the Convention include:

- Measures and incentives for the conservation and sustainable use of bio-diversity
- Fair and equitable ways of sharing results of research and development and the benefits arising from commercial as well as other utilization of genetic resources
- Access to and transfer of technology including biotechnology to government as well as to local communities
- Scientific and technical cooperation
- Provision of financial resources
- Education and public awareness
- Impact assessment and implement treaty commitments

The Cartagena Protocol

The Cartagena Protocol on Biosafety (Biosafety Protocol) was adopted in January 2000 and entered into force on 11 September 2003. The main aim of the Protocol was to protect biodiversity from potential risks posed by living modified organisms which is the gift of modern biotechnology.

Check Your Progress

3. What is the mission of UNEP?
4. Where did the Earth Summit happened?
5. What were the aims of the Convention on Biological Diversity?

8.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

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1. Antarctica is the driest, windiest and coldest of all the continents.
2. The United Nations Conference on the Human Environment, also known as the Stockholm Conference, was an international conference convened under United Nations auspices held in Stockholm, Sweden from June 5-16, 1972.
3. UNEP's mission is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.
4. United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', was held in Rio de Janeiro, Brazil, from 3-14 June 1992.
5. The Convention on Biological Diversity (CBD) is an international treaty adopted in Rio de Janeiro, Brazil in June 1992 with the following three main objectives: (i) Conservation of biodiversity (ii) Sustainable use of the components arising from it, and (iii) Sharing of benefits of genetic resources in a fair and equitable way.

8.6 SUMMARY

- Antarctica is deeply covered with ice with an average thickness of about 1800 metres. With increase in distance from the sea, the thickness of the ice increases and reaches up to about 4200 metres.
- There are no living creatures including plants or trees in the interior of the Antarctica.
- Different parts of Antarctica were claimed by seven countries, namely Argentina, Chile, France, United Kingdom, Norway, Australia and New Zealand. However, the Antarctic Treaty signed in 1959 froze all political claims.
- Industrialization has brought about modernization of lifestyle and its associated benefits. Health-giving medicines, labour-saving household appliances, automobiles and ships, paints and detergents, synthetic fibres and polythene packaging, personal computers and TVs—the list of useful manufactured goods is almost endless. But with the goods come the bad effects.
- By the 1980s, the international community launched treaty negotiations under the auspices of the United Nations Environment Programme. In March 1989,

they adopted the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

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- The United Nations Conference on the Human Environment (also known as the Stockholm Conference) was an international conference convened under United Nations auspices held in Stockholm, Sweden from June 5-16, 1972.
- The United Nations Environment Programme (UNEP) is the leading environmental authority in the United Nations system.
- UNEP re-organised its work programme into six strategic areas as part of its move to results based management. The selection of six areas of concentration was guided by scientific evidence, the UNEP mandate and priorities emerging from global and regional forums.
- The United Nations Conference on Environment and Development (UNCED), also known as the 'Earth Summit', was held in Rio de Janeiro, Brazil, from 3-14 June 1992.
- The Rio de Janeiro conference highlighted how different social, economic and environmental factors are interdependent and evolve together, and how success in one sector requires action in other sectors to be sustained over time.
- The 'Earth Summit' concluded that the concept of sustainable development was an attainable goal for all the people of the world, regardless of whether they were at the local, national, regional or international level.
- In 1992, the United Nations Conference on Environment and Development (UNCED), held at Rio de Janeiro, adopted a declaration and a global agenda for management of the environment in the next century. The declaration is known as Agenda 21.
- Biological diversity is the variety and variability among living organisms and the ecological complexes in which they occur.
- The Convention on Biological Diversity (CBD) is an international treaty adopted in Rio de Janeiro, Brazil in June 1992.
- The Cartagena Protocol on Biosafety (Biosafety Protocol) was adopted in January 2000 and entered into force on 11 September 2003. The main aim of the Protocol was to protect biodiversity from potential risks posed by living modified organisms which is the gift of modern biotechnology.

8.7 KEY WORDS

- **Transboundary Movement:** It means any movement of hazardous wastes or other wastes from an area under the national jurisdiction of one State to or through an area under the national jurisdiction of another State or to or

through an area not under the national jurisdiction of any State, provided at least two States are involved in the movement.

- **Hazardous Wastes:** It means waste that has substantial or potential threats to public health or the environment.
- **Biodiversity:** It means the variety of plant and animal life in the world or in a particular habitat, a high level of which is usually considered to be important and desirable.

8.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Write a short note on the Antarctic Treaty.
2. What was the importance of the Stockholm conference?
3. What is the significance of Earth summit of 1992?

Long-Answer Questions

1. Discuss the three-step strategy adopted in the Basel Convention on minimizing hazardous wastes.
2. Describe the strategic areas of work programme of UNEP.
3. Explain the various issues dealt with in the Convention on Biological Diversity.

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BLOCK III
ENVIRONMENTAL THREATS AND THE REASON

UNIT 9 ENVIRONMENT THREATS-I

Structure

9.0 INTRODUCTION

Global environmental changes can also be very hard to see—they often occur slowly or intermittently, sometimes almost imperceptibly, and on global scales, and they can be obscured by normal fluctuations in things like temperatures or rainfall, which are changing naturally and often abruptly and with large swings all the time. In this unit, we will study about two such environmental threats, viz., water pollution and air pollution. Water pollution occurs when harmful substances, usually chemicals or microorganisms, contaminate a stream, river, ocean or an aquifer, degrading water quality and rendering it toxic to humans or the environment. Water being a universal solvent, is able to dissolve more substances than any other liquid on earth. That is why water is so easily polluted. Toxic substances from farms, towns, and factories readily dissolve into and mix with it, ultimately causing water pollution. These pollutants that mix with water can be of varying kinds: organic, inorganic, radioactive and so on. Degrading water quality is damaging the environment, health conditions and the global economy. Some of the effects of water pollution are destruction of biodiversity, contamination of food chain, lack of potable water, spreading of diseases like cholera, hepatitis A and dysentery and high infant mortality rate. Similarly, living beings also bear the repercussions of air pollution. A toxic substance, living or non-living, at an undesirable limit is called a pollutant. Such a substance when present in air is called air pollutant. The process of polluting the air and making it unsafe for living is called pollution of air. Car

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emissions, chemicals from factories, dust, pollen and mold spores may be suspended as particles. Ozone, a gas, is a major part of air pollution in cities. When ozone forms air pollution, it's also called smog. Some air pollutants are poisonous. Inhaling them can increase the chance you'll have health problems. People with heart or lung disease, older adults and children are at greater risk from air pollution. Air pollution is not just outside - the air inside buildings can also be polluted and affect your health. In this unit, we will study in detail about water pollution and air pollution.

9.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the sources of water pollution and the preventive measures to control it
- Explain the impurities present in water and their harmful impact on living beings
- Discuss the wastewater treatment methods
- State the causes and effects of air pollution
- Illustrate the methods and devices used to remove pollutants from air

9.2 WATER POLLUTION

Water pollution can be defined as an alteration in physical, chemical or biological characteristics of water, making it unsuitable for the designated use in its natural state.

Sources of Water Pollution

Water is an essential commodity for survival. We need water for drinking, cooking, bathing, washing, irrigation and for all industrial operations. Water has the property to dissolve many substances in it. Therefore, it can easily get polluted. Pollution of water can be caused by point sources or non-point sources. Major point sources of water pollution are industries, power plants, underground coal mines, offshore oil wells, etc.

On the basis of location, water pollution is divided into two types.

1. Groundwater Pollution
2. Surface Water Pollution

Groundwater pollution

Groundwater forms about 6.2 per cent of the total water available on planet earth, and is about thirty times more than surface water, i.e., streams, lakes and estuaries.

Septic tanks, industry (textile, chemical, tanneries), deep-well injection, mining, etc., are mainly responsible for ground water pollution which is irreversible. Ground water pollution with arsenic, fluoride and nitrate pose serious health hazards.

Surface water pollution

The major sources of surface water pollution are:

1. Sewage
2. Industrial effluents
3. Synthetic detergents
4. Agrochemicals
5. Oil
6. Waste heat

Effects of Water Pollution

The following are some of the important effects of various types of water pollutants:

1. Oxygen-demanding wastes
2. Nitrogen and phosphorus compounds (nutrients)
3. Pathogens
4. Toxic compounds
5. Waterborne diseases
6. Reduction in dissolved oxygen in water resources

Pesticides in drinking water ultimately reach humans and are known to cause various health problems. DDT, aldrin, dieldrin, etc., have therefore, been banned. Recently, in Andhra Pradesh, people suffered from various abnormalities due to the consumption of endosulphan contaminated cashew nuts.

Control of Water Pollution

It is easy to reduce water pollution from point sources by legislation. However, due to absence of any defined strategies it becomes difficult to prevent water pollution from non-point sources. The following points may help to reduce water pollution from non-point sources.

1. Judicious use of agrochemicals like pesticides and fertilizers which will reduce their surface run-off and leaching. Avoid the use of these on sloped lands.
2. Use of nitrogen-fixing plants to supplement the use of fertilizers.
3. Adopting integrated pest management to reduce reliance on pesticides.
4. Prevent run-off of manure. Divert such run-offs to basin for settlement. The nutrient rich water can be used as fertilizer in the fields.
5. Separate drainage of sewage and rain water should be provided.

6. Plantation of trees would reduce pollution and will also prevent soil erosion.
7. Industrial effluents to be allowed only after treatment.

9.2.1 Nature

Water the most abundant and wonderful of all natural resources, is extremely essential for the survival of all living organisms. Water that is found in nature is called natural water. The natural water (sea water, rivers, lakes, polar ice and glaciers) contains numerous organisms like phytoplankton, zooplankton, fish and many other things. Water contains dissolved gases like oxygen, essential for aerobic aquatic organisms, carbon dioxide for small plants to bloom so as to be utilized by aquatic animals. Pure water on the other hand, means water free from living organisms, especially microbes, all sort of toxic substances, having salts in the tolerable limits. The pure water is absolutely necessary for drinking and cooking, besides for industry, agriculture and various other activities. But today, pure water has become a precious commodity and its quality is threatened due to pollution. The water pollution thus, can be defined as the deterioration of physical, chemical and biological characteristics of water through natural as well as anthropogenic activities, to such an extent that it has become harmful for all living organisms including man. Water pollution has now become a global problem affecting both the developed and developing countries.

The following are the signs of water pollution:

(*a*) Bad taste and offensive odour

(*b*) Unchecked growth of aquatic weeds

(*c*) Decreased number of fish

(*d*) Floating of oil and grease on water surfaces

Water Pollutants: Their Origin and Effects

There are large number of water pollutants. For our convenience, they have been classified into five different categories:

(*i*) Organic pollutants (*ii*) Inorganic pollutants (*iii*) Suspended solids and sediments (*iv*) Radioactive pollutants and (*v*) Thermal pollutants

Organic pollutants

The organic pollutants present in water may be classified into five different categories such as: (*i*) oxygen demanding waste (*ii*) disease causing waste (*iii*) synthetic organic compounds (*iv*) oil (*v*) sewage and agricultural runoff.

Oxygen demanding wastes: One of the most important measures of water quality is the amount of dissolved oxygen (DO) present in it. The saturated value of DO in water is in the order of 8 to 15 mg /l. Optimum DO required for healthy fish and other aquatic life in natural water is 5 to 8 mg/l. If DO drops, fish and other aquatic life is threatened and in extreme cases, killed. The other effect of

reduced DO is undesirable taste, odour and colour, prohibiting its use for domestic and recreational purposes. The oxygen demanding wastes are generally biodegradable organic matter contained in sewage, industrial wastes from food processing, paper mills and tanneries, agriculture return, etc. These organic wastes provide a good substrate for the luxuriant growth of aerobic bacteria which decompose the waste and deplete the oxygen.

The two most important measures of oxygen demand are: (1) chemical oxygen demand (COD) (2) biological oxygen demand (BOD). Chemical oxygen demand (COD) is the amount of oxygen required to oxidize the wastes chemically. BOD is the amount of oxygen required by micro- organism to decompose the wastes biologically.

Pathogens

Pathogens are disease causing microorganisms which grow and multiply within the host. The resulting growth of microorganisms in a host is known as infection. Water is the carrier of such pathogenic micro-organisms, causing immense harm to public health. The pathogenic micro-organisms enter water mainly from domestic sewage and other wastes. Generally, these microorganisms occur in the faeces or urine of the infected person and finally discharge into the water body. The discharge of an infected individual may contain billions of these pathogens and if they enter the water body, epidemics might occur. Epidemics of infectious diseases generally occur in a crowded population and under poor sanitary conditions. The infectious diseases associated with water can be classified into four groups according to the mechanism of transmission.

1. ***Waterborne diseases*: They spread through ingestion of contaminated water. *Example*: cholera, typhoid, paratyphoid, bacillary dysentery.
2. ***Water-wastes diseases*: They spread through unclean water. *Example*: trachoma and scabia.
3. ***Water based diseases*: They spread through water contact, where the larva of the parasitic worm get attached to the human skin, penetrate it and ultimately enter the blood stream. They get mature in liver and lay eggs in the intestine. The intestinal discharge contaminates the water and large number of parasitic worms spread causing epidemics.

   Example: schistosomiasis and dracunculiasis.
4. ***Water-related diseases*: In such diseases, human contact with water is not needed. It is the host which depends on water for its habitat.

   Example: Malaria, filaria, dengue, etc.

Different diseases are caused by different pathogens. For example, virus is responsible for hepatitis, meningitis, myocarditis, etc. Bacteria are responsible for cholera, typhoid, paratyphoid, etc. Protozoa are responsible for diarrhoea, dysentery, etc. Parasitic worms such as helminthes are responsible for diseases like ascariasis, trichuriasis, etc.

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Nutrients

Nutrients are chemicals essential for the growth of living things. For plants there are sixteen elements required for their healthier growth. They are carbon, hydrogen, oxygen, (obtained mainly through CO_2 and water from the soil), nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients such as iron, cobalt, manganese, boron, molybdenum and copper.

The nutrients can become a pollutant when their enrichment allows thick growth or blooms of aquatic weeds, especially algae that cover up water. This prevents the entry of sunlight into water bodies. Aquatic plants, along with algae, thus die, the bacteria present in water now decompose all these dead plants and ultimately reduce the dissolved oxygen (DO) in water. The decayed organic matter adds unwanted colour, odour, taste and turbidity to the water and acceptability for domestic purpose is reduced. The depletion of dissolved oxygen leads to the death of fishes, other aquatic animals and plants. The process of nutrient enrichment is known as eutrophication.

Among the sixteen elements, carbon, nitrogen and phosphorus are the most important nutrients which control the growth of algae blooms. Carbon is available from the atmosphere as CO_2 and decaying of other organic matter cannot be controlled. It is nitrogen and phosphorus which can be controlled to check algae growth rates.

The major sources of nitrogen and phosphorus polluting water bodies are soaps and detergents, chemical fertilizers like urea, ammonium sulphate or nitrate, super phosphate, etc. Besides eutrophication problems, if water contains enough nitrates (NO_3–) and is consumed by children, certain bacteria in the intestinal tract of infants can convert nitrates to highly toxic nitrites (NO_2–). Haemoglobin has higher affinity for nitrites compared to oxygen, therefore it leads to replacement of oxygen by nitrites causing a bluish discoloration of the infant and is commonly referred to as 'blue baby' syndrome.

The phosphorus from chemical fertilizers as well as detergents help algae growth, resulting in enormous blooms. In detergents, the phosphates are in the form of tripolyphosphate. This tripolyphosphate slowly reacts with water forming orthophosphate and is used by plants for their growth.

Salts

Water accumulates a variety of dissolved solids or salts while passing through soils and rocks and on its way to the sea. Generally, the cations in the salt are sodium, potassium, calcium and magnesium and the anions are chloride, sulphate and bicarbonate. The measure of salinity of water is usually the measure of concentration of total dissolved solids (TDS). Water having less than 1500 mg/l of TDS is considered to be fresh water, and above 5000 mg/l saline water.

Drinking water has the recommended maximum TDS concentration of 500 mg/l. With concentration of TDS exceeding 2100 mg/l, irrigation becomes difficult.

Again, if the sulphate and chloride salts of calcium and magnesium are present in excess amount, it is very expensive to wash clothes as it consumes excess soap. Again, if such water is used in the steam boilers, it will cause scaling due to precipitation of salts resulting in reduced lifetime of the boilers due to corrosion.

Thermal Pollution

Heat cannot be completely converted into work. Hence, waste heat will always be produced where heat is converted into mechanical work. In thermal power plants, nuclear power plant, etc., where water from the nearby river or lakes is used as a coolant, the waste hot water is returned to the original water body and on an average the temperature is raised by 10°C. The rise in temperature decreases the amount of dissolved oxygen (DO) in water, adversely affecting the aquatic life. With rise in temperature the metabolic rate increases, whereas supply of DO decreases (with rise in temperature, solubility of O2 decreases and the dissolved O_2 escapes, further bacterial decomposition of organic wastes goes on a rapid rate).

Furthermore, the fish and other aquatic animals may be sucked into the intake pipe killing them in large numbers. In case of nuclear power plants, there always remains the possibility of release of radioactive elements into the water body and with prolonged time it may build up to a dangerous level.

Heavy Metals

Heavy metals are referred to as metals with specific gravity greater than about 4 to 5. The most important heavy metal pollutants are mercury (Hg), lead (Pb), cadmium (Cd) and arsenic (As).

Pesticides

Chemicals which prevent, destroy or mitigate any pest (insects, fungus, bacteria, viruses, etc.) are called pesticides. Pesticides are classified on the basis of (*i*) chemical structure (*ii*) biological action (*iii*) class of pests they combat.

Some chemicals, however, fall into more than one category. For example, parathion, while being an insecticide, is also a nematicide and acaricide.

The main groups of pesticides of our concern are insecticides. With increase in population growth man had to increase agricultural productivity. Use of insecticides, like DDT has not only improved the productivity of agricultural goods by protecting crops from pests but has also contributed in curbing diseases, like malaria which once was an epidemic. However, the extensive use of insecticides has proved that its use is not entirely in the interest of man due to its harmful side effects. There are three main groups of pesticides namely organochlorines, organophosphates and carbamates.

A great variety of insecticides, under different technical and trade names are used. Although the targets of pesticides are insects, fungus, nematodes and rodents

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which damage crops, they also target non-target beneficial organisms like earth worms, fish, birds, mammals and man. The killing of such species disturbs the balance of natural cycle and also the evolution of new species, necessitating more severe environmental control measures. The harmful effects of insecticides thus, have been a great cause of concern and persistence of insecticides in the environment after application is not at all desirable from environmental considerations.

The most widely used organochlorine pesticide is DDT (dichloro diphenyl trichloroethane), which has controlled insects carrying diseases like malaria (mosquitoes), plague (fleas) and typhus (body lice). The organochlorine insecticides are highly toxic to insects, but acute human toxicity is low. It is the bio-accumulation of organochlorine pesticides such as DDT in the food chain which creates toxicity. Such type of insecticides persist longer in the environment before undergoing degradation to other substances and are quite soluble in hydrocarbons and, easily accumulate in the fatty tissues. And so, because of their build up in the food chain, they get magnified to higher trophic level. Birds are high on the food chain and thus, more accumulation of DDT has adverse effects, interfering with enzyme regulating distribution of calcium, resulting in thinning of egg shell that supports its weight. The resulting difficulty to reproduce due to high levels of DDT, has brought the hunting birds like bald eagle, ospreys and brown pelicans on the verge of extinction.

The accumulation of DDT in human body is through food chains, *i.e.*, vegetables (foliar spray of DDT is absorbed on the leaf), fish , milk (animals like cows, buffaloes eating DDT accumulated vegetables and so the milk also gets contaminated, humans consume milk, thus get severely affected and breast fed babies ultimately get affected).

The other organochlorines widely used are chlordane, aldrin, endrin, dieldrine, kepone, etc.

Some of these types of insecticides show birth defects in mice, hamster and some cause liver cancer. Kepone, a class of plant insecticide, finds its application in controlling tobacco wire worm, ants and cockroaches. Exposures to this insecticide can cause severe neurological damage and when they undergo decomposition and are discharged into water, they can ultimately be incorporated into the food chain.

As far as the effect of organochlorines is concerned, they pose a serious threat to the eco-system, human health and moreover, the long term use of such chemicals is no longer found to be effective in controlling the pests due to the biological assistance development in these pests against the pesticides. Thus, another class of insecticides which are not persistent have been developed and are being replaced. Some examples of this class are Malathion, Phosdrin, Guthion, Diorom, etc. Although these insecticides are not accumulated in the food chain, they pose direct threat. They get absorbed rapidly through skin, lungs and gastro-intestinal tract and become acutely toxic than the organo chlorines that they have replaced.

Excessive amount of such types of insecticides cause chest discomfort, vomiting, headache, nervous disorder, etc.

The third category of insecticides, carbamates, is derived from carbamic acid (NH2 COOH). These insecticides are not persistent like organo chlorines, but they get absorbed as organo phosphate insecticides, causing acute toxicity. Some of the carbamate insecticides are aldicarb, carbaryl, etc. Exposures to such chemicals cause blurred vision, nausea, vomiting. The accumulation of DDT in the body tissue of an average Indian is much greater than anyone in the world.

Some other pesticides commonly used to kill pests are:

***Fumigants*:** The insects die inhaling poisonous gaseous or fumigants like HCN vapour, CH3Br, PH3, para dichlorobenzene, nicotine, chloropicrin, etc.

***Fungicides*:** Fungus on plants and crops are killed by quinones, organomercury and its compounds and phenols.

***Bactericides or antibiotic*:** Bacterial growth in plants is checked or removed completely by streptomycin spray.

***Rodenticides*:** Rats like animals are killed by thallium sulphate, zinc phosphide, etc.

Pesticide Poisoning

The indiscriminate use of pesticides in agriculture has posed a serious threat to human and animal life. Non-biodegradable pests accumulating in the food chain and biodegradable pests leaving behind more toxic side products, have produced health hazards with concentration exceeding the safe tolerance level.

Thus, a new technology must be introduced to safeguard the ecology. New types of chemicals having no side effects or minimum side effect should come. Neem-based insecticides could be a good alternative. If proper research is carried out it could be utilized as eco-friendly substitute of other commonly used pesticides.

Volatile Organic Compounds (VOC)

As the name implies these organic compounds have low boiling point and evaporate quickly into the atmosphere. These chemicals are either synthesized directly or may be obtained as side product. From the atmosphere it comes down to the surface along with rain or from the industry it can go directly into the nearby river or sea or other water resources. From the surface it can get evaporated into the atmosphere causing air pollution and if it seeps underground, its evaporation process will slower down resulting in high degree of ground water pollution. Chlorinated hydrocarbons can also be used as herbicides. For example, 2, 4, 5-trichlorophenoxy acids or 2, 4-dichlorophenoxy acid. They are used for killing weeds and undesirable vegetation. However, such types of chemicals are banned or need to be banned as the side-products obtained during their synthesis are highly toxic dioxin. Herbicide like paraquat used to destroy marijuana.

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The volatile organic compounds are found to be either carcinogens or mutagens. Five such compounds are generally found to be highly toxic:

Vinyl chloride**:** It is used to produce polyvinyl chloride resins and is most toxic as it is a suspected carcinogen.

Trichloroethylen**e:** A commonly used cleaning agent and is a suspected carcinogen and ground water contaminant.

Tetrachloroethylene**:** Major component in the production of chlorofluorocarbons and causes tumors in animals.

Carbon tetrachloride**:** Finds application in fire extinguisher, synthesis of various chemicals, fumigants. Insoluble in water and trace amount found in water and is toxic when ingested.

1, 2-Dichloroethylene**:** Used to produce various products including vinyl chloride, tetraethyl lead and soap compounds. It can effect central nervous system, liver and kidney if it exceeds tolerance level.

Eutrophication

The word eutrophication is originated from Greek words *eu* = 'well' and *trophes* = 'food'. Thus, it means 'well fed' or 'nutrient rich'. So, we can define eutrophication as excessive nutrient load in a water body or enrichment of water body by nutrients.

Nutrients may become pollutants if their concentration is sufficient to allow excessive growth of aquatic plants, especially algae. An aquatic system may be categorized into three classes in accordance with the nutrient status, *i.e.*, concentration of nutrients and productivity of aquatic plants.

(*i*) ***Oligotrophic*****:** Water with poor nutrient status and very low productivity of aquatic plants.

(*ii*) ***Mesotrophic*****:** Water with moderate (not low not high) nutrient status and moderate productivity of aquatic plants.

(*iii*) ***Eutrophic*****:** Water with rich (sufficient concentrations) nutrient status and high productivity of aquatic plants.

A young lake or a newly formed lake has low nutrient content and thus, low plant productivity. Such types of lakes (oligotrophic lakes) with time acquire nutrients from surface runoff, drainage basins, excreta and exudates of animals using the water source, which ultimately increase aquatic growth. In this way, the oligotrophic water bodies turn gradually into mesotrophic water bodies.

With time, the nutrient status of the water bodies gradually increases. The biological productivity thus enhanced, leads water to become murky with phytoplankton, *i.e.*, algae blooms to occur. The lake thus, becomes eutrophic (well-fed).

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Eutrophication is a natural process and may take thousands of years. However, this is greatly enhanced through human activities and is termed as accelerated or cultural eutrophication. The industrial wastes, municipal waste water, run-off from agricultural lands, provide plenty of phosphates, nitrates and various minerals stimulating algal growth. Due to which, the water body becomes green. In due course of time, the algal blooms may die abruptly. The decaying organic matter causes depletion of oxygen level, destroying fish habit and other aquatic species. Bad taste, bad odour, turbidity, thereby, greatly reduce its acceptability as a domestic water source. Again, because of the silt and organic debris the lake slowly becomes shallower and shallower, more plants spread roots along the shallow edges and the lake slowly transforms into a marsh and finally converts into a dry land. Thus, a water body so useful for us becomes totally useless within a short span of time, due to anthropogenic activities.

Controlling Eutrophication

The main causes for the production of algae are the available nutrients. The three main nutrients are carbon, nitrogen and phosphorus. If the supplies of such nutrients are restricted, growth will be reduced. Carbon is usually available from natural sources and can be less restricted, so is nitrogen, as certain bacteria and blue-green algae fix atmospheric nitrogen. However, it is phosphorus which has least available natural sources and can be restricted. Anthropogenic activities provide enough phosphorous for algae bloom. The main anthropogenic sources of phosphorous are agricultural runoff and domestic sewage. In domestic sewage, the source of phosphorus is the human faeces and detergents. Human faeces cannot, however, be restricted but the use of phosphorus in detergents can be limited.

The other steps used in controlling eutrophication are recycling of nutrients through harvest, removal of algal blooms by drudging, applying algaecides like copper sulphate, chlorine, etc., on water bodies.

It is observed that phosphorus in excess of 0.015 mg/l and nitrogen in excess of 0.3 mg/l are sufficient to cause algal bloom.

9.2.2 Wastewater Management

Wastewater treatment methods are practices followed to purify the polluted water from an industry before it is disposed of into a large water body. One might assume that such a treatment is not necessary and the disposal into a large body would sufficiently dilute the pollution in the industrial water to render it harmless. In reality, this is not the case because the untreated industrial water contains insoluble wastes like plastic and chemicals which get released into streams and rivers. Such insoluble wastes pose a major threat to the aquatic life and may lead to its depletion. Therefore, wastewater treatment is essential to keep natural water sources pollution-free.

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Generally, wastewater is stored and then subjected to treatment in batches. This ensures that every batch, which is treated in a treatment plant, has been cleared of harmful pollutants and chemicals.

Convenient methods for wastewater treatment are the basic methods used to treat the water collected from industries and sewers. These methods are categorized according to three stages of water treatment: primary methods (physical) for primary stage of water treatment, secondary methods (biological) for secondary stage and advanced methods (chemical) for advanced stage. The following sections describe these stages in detail.

Primary Treatment

This is the most basic form of treatment that is given to wastewater of any kind. Through primary processes, coarse solids and large materials are separated from wastewater. For primary treatment, wastewater is sent to a large tank where its constituent solids and impurities are allowed to settle at the bottom. Primary treatment is restricted to separation of large impurities only because small particles take too long to settle. Smaller particles are removed by other processes. In primary treatment, wastewater is subjected to very calm circular currents because turbulent currents won't allow the pollutants to settle down. Primary treatment does not remove organic soluble impurities. The waste that is collected through this process is called primary sludge and is sent elsewhere for treatment and processing. Many impurities which might linger on water surface after primary treatment are collected through skimming. The scum so collected also needs treatment before it could be disposed of.

Through primary treatment the following can be removed: between 25–50% of biochemical oxygen demand (BOD), 50–70% of total suspended solids and 65% of oil and grease. A certain amount of organic nitrogen, organic phosphorus and other heavy metals are also removed through this settling method. The tanks, used for the primary treatment process, usually have circular or rectangular shapes and are four metres in depth. The settling time for wastewater impurities in these tanks is usually between two and three hours.

Secondary Treatment

Primary treatment is followed by secondary treatment to remove organic or biodegradable wastes. Secondary wastewater treatment is also called biological wastewater treatment because it allows micro-organisms to feed on the organic waste in the water for its removal. The removal of organic waste is carried out in two ways: through aerobic treatment and anaerobic treatment of wastewater. In aerobic treatment, bacteria devour the organic wastes in the presence of oxygen. In anaerobic treatment, bacteria devour the organic wastes in the absence of oxygen.

In the secondary treatment of wastewater, organic impurities are removed through aerobic treatment. For aerobic treatment, wastewater is subjected to an army of starved micro-organisms along with a gush of air, as depicted in Figure

9.4, e.g., many municipalities use this method for treating wastewater in India. These organisms use this stream of air to breathe and convert the organic and biodegradable wastes into their food. This basic activity, carried out to support the metabolism of micro-organisms, converts the waste into more similar micro-organisms which can be collected and used again for the same purpose.

The tanks used for secondary treatment are similar to those used in primary treatment. The sedimentation or waste, resulting in secondary treatment, comprises the old as well as new micro-organisms from the water. The collected waste is called secondary sludge which is mixed with primary sludge for further treatment. Three different methods or processes, used for secondary treatment, are described below:

(a) **Activated sludge:** In this process, wastewater is collected in a basin and it is constantly moved. The air is pumped into the water using aeration devices submerged in the water. Then a mix of liquor and micro-organisms is introduced in the water to carry out the secondary treatment procedure. The extra micro-organisms produced in the water are regularly removed to make sure there is a balance in the level of micro-organisms and liquor in comparison to the amount of water. The time spent by wastewater in this tank can vary from three to eight hours.

(b) **Trickling filters:** A trickling filter is an aerobic treatment system that is used to remove organic matter from wastewater. It is also called trickling biofilter, biological filter and biological trickling filter. A trickling filter is filled with a high specific surface-area material such as rocks, gravel, shredded PVC bottles, or special pre-formed filter-material. Both ends of the filter are ventilated to allow oxygen to travel the length of the filter. A perforated slab supports the bottom of the filter to facilitate collection of the effluent and excess sludge.

The pre-treated wastewater containing organic matter is 'trickled' through the filter surface. As wastewater trickles through the filter pores, its organic load is oxidized into carbon dioxide and water by the organisms that grow in a thin bio-film over the filter surface. In the process, a slime layer of microorganisms is developed over the filter surface. With time, the slime layer will grow thick and will be deprived of oxygen. Consequently, it will lose its ability to stay attached and will slough off as effluent. The effluent should be clarified in a settling tank to remove any biomass that may have dislodged from the filter.

Trickling filters are known as attached-growth processes. In contrast, systems in which microorganisms are sustained in a liquid are known as suspended-growth processes.

(c) **Rotating biological contractors:** These consist of rotating discs which are layered with micro-organisms. The rotating mechanism

supplies air required for aerobic treatment of organic matter in wastewater. Parts of the disc which have been covered in sludge are removed and put aside either for further treatment or use in other micro-organism treatment.

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After secondary treatment by any of the above-mentioned processes, the treated water can be sent for advanced treatment or can be used for secondary purposes.

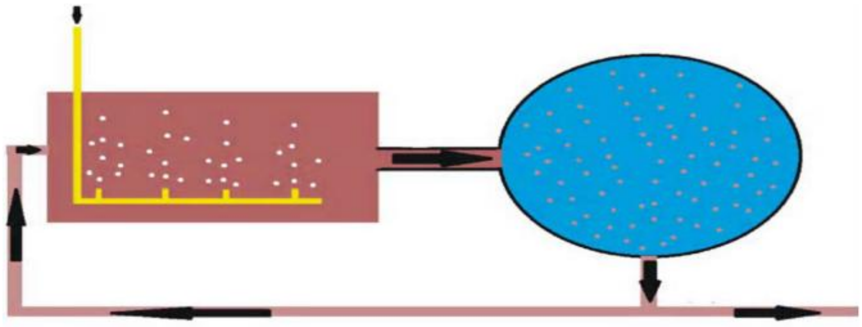


Fig. 9.1 *Secondary Wastewater Treatment*

Source: http://www.fao.org/docrep/t0551e/t0551e07.htm#TopOfPage

Advanced Treatment

This is the final phase in wastewater treatment. Advanced treatment is used to remove any impurities left in the water after primary and secondary treatments and to alter the mineral or nutrient content of the water. It is also called tertiary treatment. In advanced methods, chemicals are used as catalysts to carry out reactions required to get the water of desired contents. Nutrients like nitrogen, phosphorus and heavy metals are removed from water through advanced treatment. Sometimes wastewater is subjected directly to advanced treatment without first going in for primary and secondary treatment.

Eco-Friendly Methods

The above methods of water pollution management are heavily dependent on technology infrastructure and sometimes also use chemicals for water cleaning. In contrast, eco-friendly methods of water pollution management use resources from the environment for water decontamination. Eco-friendly methods combine human efforts with the environment's cleansing capabilities to decontaminate wastewater. Actually, recent researches have found that the environment itself is equipped with necessary tools to rid water of its impurities. Therefore, efforts are being made to integrate human efforts with the environmental capability to decontaminate water in an eco-friendly way. Some of the eco-friendly methods of water pollution management are as follows: Constructed wetlands and anaerobic treatment.

Wastewater Collection and Maintenance

Wastewater collection and maintenance is the first step in the integrated water treatment plants. This is the basic preparation of wastewater for treatment. It involves bringing all the water from different parts of the industry to the treatment plant and collecting it in one single tank. The wastewater could even be collected in smaller tanks to treat it in batches as per its use. This collection of wastewater allows the workers at the integrated treatment plant to see the kind of wastes they would be dealing with and then take appropriate decisions.

Maintenance of wastewater involves taking preparatory steps to ensure its proper treatment. This initial stage includes removal of large impurities from the water which can simply be picked off using a large sieve. If the water is acidic, it needs to be balanced to get a more neutral PH level before it could be sent for treatment. Also, in this stage, water remains stagnant for a considerable time before being sent in batches for processing. This facilitates settling down and removal of large impurities such grit, grease and coarse materials.

Wastewater Treatment

This treatment is a combination of physical, chemical and biological treatments that the water is subjected to for cleaning its impurities. These treatments can be used individually or in combination with one another depending on the required level of treatment and the kind of impurities in the water. The end use of the treated water also determines the kind of treatment it needs to be subjected to.

Once sludge has been treated, it is sent for disposal. It can either be disposed of at sludge landfills or dehydrated and turned into solid cakes. These cakes are picked up by other manufacturing companies and turned into fertilizer pellets. With the use of fertilizer pellets in agriculture, sludge is returned to the environment.

Wastewater Reuse

The terms 'wastewater reuse', 'wastewater recycling' and 'wastewater reclamation' are used synonymously. The main objective of wastewater reuse is to find economic and environment-friendly alternatives to meet the present demand for water without compromising with the nature's need for maintaining a certain amount of clean water as well.

The treated wastewater is used for many purposes some of which are described below:

- **Urban Reuse:** Wastewater after treatment is used in water public parks, school yards, flushes, drain cleaning and in a number of commercial buildings. It is also used for landscaping in houses and in public and commercial air conditioners which need large amounts of hydration.
- **Agricultural reuse:** It is used in the irrigation of non-food crops. It is not used for food crops because it is not completely treated and is not fit

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to be mixed with anything which will be consumed by humans. However, after high-quality treatment, wastewater could be fit for food crops as well as used in local nurseries and small plantations.

- **Recreational impoundment:** Wastewater can be used to rebuild small water bodies in certain areas where drought has destroyed the natural and scenic beauty.
- **Environment reuse:** Wastewater can be used in the construction of wetlands and for enhancing existing natural and man-made wetlands. It is also used to regulate water flow in a number of streams.
- **Industrial reuse:** Wastewater is pumped into cooling towers to maintain a certain temperature of machinery or it is used in makeup water.

Check Your Progress

1. Define water pollution.
2. List the major sources of surface water pollution.
3. What are pathogens?
4. What are heavy metals?
5. What do you mean by wastewater treatment methods?
6. What is the main objective of wastewater reuse?

9.3 AIR POLLUTION

The Air (Prevention and Control of Pollution) Act, 1981 defines 'air pollutant' and with reference to them defines air pollution. 'Air pollutant' means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment. Air pollution means the presence in the atmosphere of any air pollutant. In this connection, the definition of 'emission' is also relevant. 'Emission' means any solid, liquid or gaseous substance coming out of any chimney, duct or any other outlet. There are 'standards' and legislation that exist for emissions.

Approximately 95 per cent of earth's air occurs in the lower levels, the troposphere. In the natural state, air contains 78 per cent nitrogen, 21 per cent oxygen, 0.4 per cent carbon dioxide plus small amounts of other gases and water vapour. The remaining 0.5 per cent of the planet air occurs in the upper levels, the stratosphere together with gases like ozone.

Air pollutants can be primary or secondary. Primary pollutants are carbon dioxide, nitrogen oxides, sulphur dioxide, carbon monoxide (all formed from the combustion of fossil fuels), CFC and particulate matter. Secondary pollutants are

acid rain and ozone. Sulphur dioxide and nitrogen dioxide combine with water in the atmosphere and react with sunlight forming acid droplets. These acid droplets constitute acid rain.

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The sources of air pollution are both natural and man-made (anthropogenic).

Natural sources: The natural sources of air pollution are volcanic eruptions, forest fires, sea salt sprays, biological decay, photochemical oxidation, extraterrestrial bodies, pollen grains of flowers, etc. Radioactive minerals present in the earth crust are the sources of radioactivity in the atmosphere.

Man-made: Man-made sources include thermal power plants, industrial units, vehicular emissions, burning of fossil fuel, agricultural activities, etc. Thermal power plants have become the major sources for generating electricity in India. The main pollutants emitted are fly ash and SO_2. Metallurgical plants also consume coal and produce similar pollutants. Fertilizer plants, smelters, textile mills, chemical industries, paper and pulp mills are other sources of air pollution.

Automobile exhaust is another major source of air pollution.

Indoor air pollution: The most important indoor air pollutant is radon gas. This is responsible for a large number of lung cancer deaths each year. These could be emitted from building materials like bricks, concrete and tiles. Many houses in the underdeveloped countries including India, use fuels like coal, dung-cakes, wood and kerosene in their kitchens. Complete combustion of fuel produces carbon dioxide which may be toxic; however, incomplete combustion produces the toxic gas, carbon monoxide.

Effects of Air pollution

1. *Effects on human health:* Years of exposure to air pollutants including cigarette smoke adversely affect the natural defenses of the body and can result in lung cancer, asthma, chronic bronchitis, etc. Many other pollutants may have toxic metals which can cause mutations, reproductive problems or even cancer.
2. *Effects on plants:* Air pollutants affect plants by entering the cells through stomata. The damage results in the death of the plant.
3. *Effects on aquatic life:* Air pollutants mixing up with rain can cause high acidity in fresh water lakes, which affects aquatic life especially fish. Some of the freshwater lakes have experienced total death of fishes.
4. *Effects on materials:* Because of their corrosiveness, particulates can cause damage to exposed surfaces.

Control of Air Pollution

Air pollution can be minimized by the following methods:

1. Setting up of industries after proper environmental impact assessment studies.
2. Using low sulphur coal in industries.

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3. Removing sulphur from coal (by washing or with the help of bacteria).
4. Removing NOx during the combustion process.
5. Removing particulate from stack exhaust gases by employing electrostatic precipitators, bag-house filters, cyclone separators, scrubbers, etc.
6. Vehicular pollution can be checked by regular tune-up of engines, converters, by engine modification to have fuel effective (lean) mixtures to reduce CO and hydrocarbon emissions and slow and cooler burning of fuels to reduce NOx emission (Honda Technology).
7. Using mass transport system, bicycles, etc.
8. Shifting to less polluting fuels (hydrogen gas).
9. Using non-conventional sources of energy.
10. Using biological filters and bio-scrubbers.
11. Planting more trees.

9.3.1 Nature

Air is precious and life cannot be sustained on this planet without it. In the troposphere, it provides oxygen for respiration, nitrogen to synthesize amino acids and proteins, carbon dioxide for carbohydrates through photosynthesis by plants, which is ultimately consumed by animals. Water vapours are required to form clouds leading to the formation of rain and snow.

Carbon dioxide absorbs infrared radiations to keep the earth warm. Thus, troposphere controls the weather conditions.

In the stratosphere, the dense layer of ozone and oxygen acts as a policeman to protect living beings from the harmful UV rays coming from the sun.

An alteration of the composition of the atmosphere by the introduction of potentially harmful substances will cause pollution and affect life on the earth severely.

The major cause of air pollution is the result of emissions of high concentrations of sulphur oxides, nitrogen oxides, carbon oxides and particulate matter. The excessive amount of sulphur oxide and nitrogen oxide is due to the burning of fossil fuels, especially coal used in power plants. The sulphur oxides form sulphurous smog.

On the other hand, the oxides of carbon, oxides of nitrogen, volatile organic compounds react with each other in the presence of sunlight to form photochemical smog. This major problem is also closely associated with motor vehicles.

There is a set of six substances, called criteria pollutants which have contributed in the formation of sulphurous and photochemical smog.

We are also getting exposed to hazardous air pollutions at home and workplace, where we spend most of our time. In the rural area people cooking with kerosene, cow dung and wood in closed conditions are severely affected.

In India, about 100 million tons of pollutants are poured into the atmosphere and the amount is increasing every year.

Criteria Pollutants

There are six pollutants which have the main contribution in creating air pollution. They are primary pollutants like carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), lead (Pb), and particulate matters (PM), with secondary pollutants like ground level ozone (O_3).

- **Carbon monoxide**: It is a colourless, odourless, tasteless, poisonous gas. It combines with haemoglobin, the oxygen carrier of the blood in the body, to form carboxy haemoglobin, a stable compound. The oxygen transportation is thus, disturbed and in extreme cases it can be fatal. However, it is a blessing that soil fungi and higher plants absorb it and destroy it by converting it into CO_2.

  Sources:

  - Incomplete combustion of coal, wood, petrol in steel plants, automobiles, thermal power plants, jet engines
  - Mid ocean surface water
  - Oxidation of CH_4 formed through anaerobic decomposition of organic matter
  - Tobacco smoking

- **Nitrogen dioxide (NO_2):** It is a reddish brown gas and exists at room temperature. At low temperature it dimerises to N_2O_4. Nitrogen dioxide is paramagnetic.

  At a lower concentration of NO as found in atmosphere, there are no adverse effects on health and green plants also absorb it without damage. But NO, which is oxidized subsequently, to form NO_2 accumulating in a higher concentration, has much adverse effect on health.

  Effects:

  - Respiratory irritation
  - Impairment of lung defense
  - Headache
  - Bronchitis
  - Loss of appetite
  - Corrosion of teeth
  - Leaf damage to sensitive plants

  NO and NO_2 also react with volatile organic compounds in the presence of sunlight to produce photochemical oxidants, which have high adverse effect on health.

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Besides human health, NO_2 has other environmental consequences too. It reacts with the hydroxyl radical in the atmosphere to form nitric acid, contributing to acid rain problems and corrosion of metal surfaces. It might cause significant damages to eutrophication and terrestrial plants.

NO is also known to be responsible for ozone layer depletion in the stratosphere.

- **Sulphur dioxide (SO_2):** It is a colourless, poisonous gas, highly soluble in water. It has a pungent and suffocating odour.

  Sources:

  - Burning of fossil fuels
  - Thermal power plants
  - Fertilizer plants
  - Textile industry
  - Steel plants
  - Sulphuric acid plants
  - Petroleum industry
  - Oil refining
  - Smelting of sulphide ores

  On an average, about 25 million tons of sulphur dioxide is emitted into the atmosphere annually.

  The main source of sulphur is fossil fuels like coal that has the maximum content of sulphur, about 1 to 6 percent. When fossil fuels are burnt, the main gas released into the atmosphere is SO_2 along with trace amount of SO_3.

  In the atmosphere we may obtain significant amount of sulphur (SO_4) aerosols.

  Effect of SO_2 on Human Health

- High solubility in water allows it to get absorbed in the moist passages of upper respiratory tract, causing increased breathing rate and feeling of air starvation.

  - Suffocation.
  - Respiratory irritation.
  - Asthma and chronic bronchitis.
  - Irritation of throat and eyes.

  The dangerous effect of this gas is that by combination with particulate matter it can act synergistically and the effect of both together being much more detrimental than either of them separately.

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SO_2 affects plants severely. SO_2 gas enters plants through the stomata and gets oxidized to SO_3 there. This SO_3 reacts with H_2O and forms H_2SO_4. The acid interferes in metabolic process and productivity falls.

Acid rain causes soil pH to go down, dissolving aluminium compounds, which ultimately hampers the uptake of nutrients.

SO_2 causes yellowing of paper and reduces its mechanical strength, affecting the storage of books. It discolours paint, causes organic fiber to weaken. Even metals get corroded easily by SO_2.

Prolonged exposure to sulphate causes damage to buildings and marble monuments, as the carbonates like lime stone and $CaCO_3$ react with H_2SO_4 to produce gypsum ($CaSO_4$), which is washed away leaving behind the eroded surface. It is now believed that there is a severe acid rain threat on the Taj Mahal.

- **Particulate Matter:** Small solid particles and liquid droplets are collectively known as particulates. In this case, the individual components aggregate to form molecular clusters (diameter 0.005 μm – 100 μm) like fumes, dust, ash, smoke, fog, oil, fly ash. Particulates are categorized on the basis of size and phase (liquid or solid). The most general term is aerosol, which is a suspension of tiny solid particles (1 μm to 50 μm) or liquid droplets, dispersed in the atmosphere. Examples of particulate matter can be listed as follows:
  - Dust – Solid particles dispersed in air.
  - Fume – Solid or liquid particles formed when vapours condense.
  - Fog – Liquid dispersed in gas medium.
  - Smoke – Carbon resulting from incomplete combustion.
  - Smog – Particulate matter originated from smoke and fog.

The chemical nature and size of the particles are very important from the pollution point of view. The particles possess large surface area and act as nuclei for many chemical reactions.

Sources:

- Volcanic eruptions, dust and soil blowing by the wind.
- Stone crushing, mineral crushing, combustion of fuels like woods, oil, coal, natural gas.
- Combustion of leaded gasoline, producing Pb particles.
- Polycyclic aromatic hydrocarbon (PAH).
- Biological materials like virus, bacteria, algae, etc.

Effects:

- Blocking of solar radiation causes the lowering of earth's temperature and affects the overall weather conditions.

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- Deposition on plant leaves affect photosynthesis.
- Respiratory disease, neural disorders, cancer.

- **Lead:** It is also known as plumbum (Pb). The important ores are galena (PbS), anglesite ($PbSO_4$), cerusite ($PbCO_3$) and lanarkite (PbO, $PbSO_4$). It is bluish grey metal (mp 327°C). It is very soft.

  Sources of lead pollution

  - Mainly automobile emissions, due to the burning of gasoline containing the anti-knock additive tetraethyl lead $Pb(C_2H_5)_4$.
  - Burning of gas and oil.
  - Glass manufacturing.
  - Mining and plumbing.
  - Metal smelters and plants, manufacturing lead–acid batteries.
  - White paint containing $Pb_3(CO_3)_2(OH)_2$ and red paint containing Pb_3O_4.
  - Lead is emitted into the atmosphere primarily in the form of inorganic particulates. The maximum portion of it however, settles down in the immediate vicinity of the source. The soil, water and food however get contaminated.
  - Water pipes made of lead can get leached, further causing lead pollution.

  Effects:

  - Liver and kidney damage.
  - Mental retardation in children.
  - Abnormalities in fertility and pregnancy.

- **Ground Level Ozone (O_3):** We have discussed the role of (O_3) in the stratosphere. In the stratosphere, ozone acts as a policeman by protecting us from harmful ultraviolet radiations.

  In the troposphere, ozone is a secondary pollutant. The mechanism of formation can be given as:

  $$NO_2 + h \rightarrow NO + O$$

  where, large concentration of NO_2, exposed to the atmosphere from various sources are photo dissociated by photons (? < 390 nm) to form NO and atomic oxygen. The atomic oxygen thus, produced reacts with O_2 gas in the presence of a third body, especially N_2, which is abundant in air and forms ozone.

  $$O + O_2 + N_2 \rightarrow O_3 + N_2$$

  Without the third body, the so formed O_3 would not have been stable and would have reverted back to O and O_2. When we inhale air containing O_3, it poses a threat.

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Volatile Organic Compounds

This class of compounds are unburnt hydrocarbons (fossil fuels not completely combusted) that enter the atmosphere when solvents, fuels and other organics evaporate. The decomposition of organic wastes and garbage also produces hydrocarbons. Examples are many—there are aliphatic hydrocarbons like methane, ethane, propane, etc., aromatic hydrocarbons like benzene, toluene, *m*–xylene that are derived from motor vehicles exhaust and industries. Aromatic hydrocarbons are more toxic than aliphatic, as they reduce WBC counts in the blood causing leukaemia and are carcinogenic. Poly-nuclear aromatic compounds also are carcinogenic.

Chlorofluorocarbons (CFCs) are also an important group of hydrocarbons causing ozone layer depletion. The aldehydes which are emitted due to incomplete combustion of fossil fuels, wood, etc., like formaldehyde, acetaldehyde, acrolein are associated with photochemical smog that causes eye and lung irritation.

Toxic Chemicals

These are the pollutants that are known to be carcinogenic, neurotoxic, mutagenic and teratogenic. There are hundreds and hundreds of toxic chemicals in the environment. These are poisonous substances, entering into the living system causing disturbances in its functioning, leading to harmful effects and even to death.

Toxin can originate from plants, animals, microbial origin and can also be a synthetic substance. The toxicants can be:

(*i*) Air pollutants (CO, NOx, SO_2, CFCs, chlorinated solvents, Pb, particulate matter, etc.)

(*ii*) Water pollutants (industrial effluents, pesticides, etc.)

(*iii*) Soil pollutants (pesticides, insecticides, etc.)

(*iv*) Food contaminants (Mercury, cadmium, arsenic, etc.)

9.3.2 Management

In this section, you will learn about the management of air polution from the angles of particulate matter, vehicular emission and planning air quality for a region.

Particulate Air Pollution Control Systems

Particulate air pollution occurs when particles of unwanted substances like dust, smoke or chemicals enter the atmosphere, making it unhealthy for the environment and living organisms. To control or eradicate particulate air pollution, certain systems or technologies are installed in the technology infrastructure of industries. These systems are referred to as particulate air pollution control systems. These systems consist of large and small air purifiers which clean industrial gaseous emissions before they are released into the atmosphere thus preventing any environmental damage. Some of the technologies used in particulate matter removal are: settling

chambers, cyclone separators, electrostatic precipitators, fabric filters, scrubbers, gaseous control technology and carbon capture technology.

Settling Chambers

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Settling chambers are large containers which are used to separate coarse particulate matter from the air to reduce its pollution. The structure of a settling chamber is similar to that of a cylinder placed in a horizontal position. The bottom of this cylinder is connected to a number of hoppers where the particulate matter is collected. The air enters the chamber from one end. The velocity at which the air enters is slowed down in the chamber. Coarse particulates are the heaviest among all particulates and can't be carried forward by the slow-speed air. Therefore, they part company with the air and settle down in the hoppers, and clean, fresh air is then blown out from the other end of the cylinder.

A major limitation of settling chambers is that they are effective in removing only coarse particulates from the air. They cannot be used to clean the air of fine particles. Normally, settling chambers are used as the first step in the air cleaning process. Thereafter, other techniques and systems are used to rid the air of fine and ultra-fine particles.

Figure 9.2 depicts a settling chamber used in the air cleaning process.

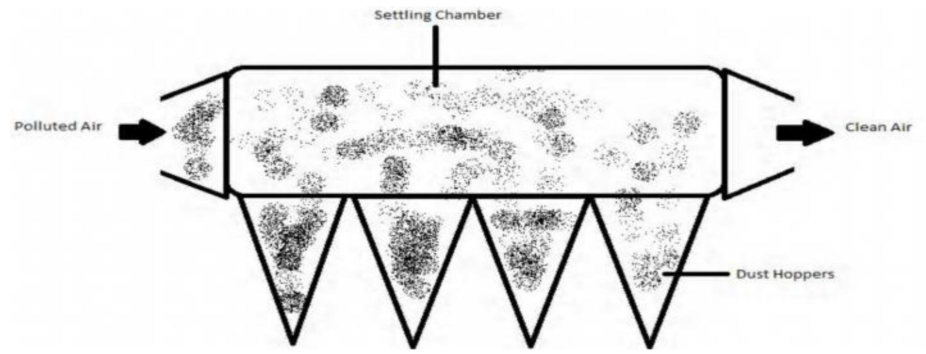


Fig 9.2 *Structure of a settling chamber*

Fabric Filters

A fabric filter, also known as baghouse, is used to separate dust particulates from dusty gases through filtration before the gases' emission into the atmosphere. A fabric filter unit, shown in Figure 9.3, consists of one or more isolated compartments containing rows of fabric bags which serve as filters. These bags could be round, flat, or shaped tubes, or pleated cartridges. The fabric bags trap fine particulates in their crevices, allowing the air to pass through. One of the most efficient and cost-effective dust collectors, fabric filters can achieve 99 per cent efficiency in the fine particulates collection.

The kind of fabric used in filters and their layout are crucial for the efficiency and effectiveness of fabric filters. Both the characteristics must facilitate passage

of maximum air through these filters with minimum particulates being carried with it. Fabrics for the filters must be carefully chosen not only to combat the dust and particulates, but also to be able to withstand high gas temperatures and the effects of harmful chemical compounds gases may carry. Most gases before sending to fabric filters need to be cooled down to facilitate their easy processing and cleaning. Fabric filters are used in combination with other filters, such as settling chambers, which first remove the larger to reduce the strain on fabric filters. Clearing the gases of larger particulates beforehand increases the life of the fabric which is used as a sieve and does not get blocked too quickly.

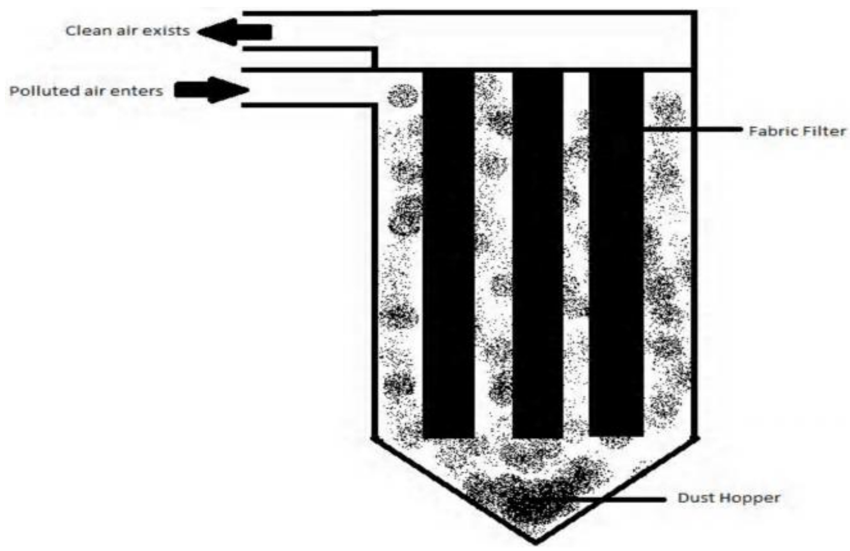


Fig. 9.3 *A fabric filter unit*

Cyclone Separators

Cyclone separators are long cylindrical containers that thin down at the bottom, forming a cone. A cyclone separator is attached to a hopper at the bottom end for gathering the particulates separated from the polluted air. Like settling chambers, cyclone separators are also used to separate course particulates from the polluted air. They function on the principle of inertia. When the polluted air enters the cylindrical-cum-conical separator, it is turned into a cyclone through constant rotation. The air starts to move at a very high speed. This change in the air speed causes inertia to sustain in the particulates. Consequently, the particulates get separated from the gas and run down the cone to the hopper, and the clean air is allowed to exit from the top of the container.

As the particulates collected in the hopper are coarse ones, therefore, the air exiting the cyclone separator needs to be pumped through other cleansing systems to make it totally pollution-free. Since the collected particulates are large in size, their accumulated collection is required to be sent for treatment and disposal. The accumulated particulate collection is mostly disposed of in a landfill.

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Scrubbers

Scrubbers use a jet of liquid, mainly water, to treat a stream of gas to remove fine particulates. Like settling chambers, scrubbers use the technique of altering the polluted air speed to separate particulates from it. The scrubber consists of a tube which is normally thick on both ends and thin at the centre (throat). When a stream of the polluted air passes through the scrubber throat, it speeds up. A jet of liquid is also injected in the throat just before the entry of the polluted air stream. Because of change in the polluted air speed and the liquid interruption, fine particulates automatically attach themselves to the heavier, slow-moving liquid stream and the pollution-free air gas flows out of the scrubber. Water droplets along with the particulates are slower and trickle down away from the air. They are collected and sent for disposal.

The scrubber method shows 99 per cent accuracy and is used commonly for its good results. A major disadvantage of the scrubber method is the production of waste water which needs to be sent to a separate treatment plant before putting it to secondary use or allowed to flow into the drain.

Electrostatic Precipitators

Electrostatic precipitators are devices that use electricity to separate particulate matter from a stream of gas. In an electrostatic precipitator, a gas stream is pushed through electrical charges. The particulates that need to be removed are charged with these electrical impulses and thus get attracted to oppositely charged metallic plates. After completion of one cycle, the metal plates are cleaned by rapping and then replaced for another cycle. The residue thus collected from the plates is sent for treatment. Later on, it is broken down into easily bio-degradable products and removed from the industrial premises.

This electrostatic precipitator method is extensively used to separate fine and ultra-fine particles from a gas before it is sent into the atmosphere. It can also be used in combination with other methods which remove large particles first to save the plates from damage. The efficiency of the electrostatic precipitator method depends on the compatibility of particulates with electrical charges and their attraction to the metallic plates. With a correct particulate charge combination, this method can give 99 per cent results. Hence, this method is very reliable.

Gaseous Control Technologies

Gaseous control technologies are used to clean an emitted gas of its harmful impurities before releasing the gas into the atmosphere. A gaseous control technology cleans an emitted gas by introducing a new compound into it. The compound would alter the chemical composition of the gas for making it pollutants-free. Due to the change in the gas's chemical composition, its pollutant content is transformed into certain compounds which can be collected as residue. Depending on the gaseous control technology being used, the machinery of the industrial unit

is designed to alter the chemical composition of the emitted gas to get its contaminants as residue. This rearrangement facilitates the release of safe gases in the environment.

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The various techniques used for gaseous control are: absorption, adsorption, biological treatment, oxidation, reduction, condensation. All of these processes are carried out at different temperatures which could range between –320ºF and 2000ºF. Thus the machinery being designed for a particular gaseous control technology should not only assist in the process but also be able to withstand extreme temperatures of the emitted gases. Absorption and adsorption are used to remove acidic gases and organic compounds. Biological treatment, oxidation and condensation are used to remove organic compounds only and thus need to be used in combination with other methods. Reduction is used particularly with nitrogen and oxygen compounds and is used as an independent process.

Carbon Capture Technologies

Whenever an industry uses fossil fuels to generate power to fulfil its needs, the result is the production of carbon dioxide in high amounts which would go into the atmosphere. Carbon capture technologies are used to release the carbon dioxide, produced in various industrial processes, in a controlled manner in the atmosphere. These technologies are designed to refine the fossil fuel emission to reduce its carbon dioxide content before its release into the atmosphere. The amount of carbon dioxide removed from the industrial emission is stored and then released in a place where it can be processed. Generally, it is released in heavily forested lands where the trees can easily take in the increased amount of carbon dioxide and use it well. Otherwise, it is introduced into the coal beds under the earth or the depleting oil and gas reservoirs deep into the mining sites. The carbon capture technologies, by reducing the carbon dioxide emission, help in controlling global warming. Besides, the extracted carbon dioxide can also be used to restore the environment where it has been depleted. The carbon capture technologies mainly rely on the use of scrubbers to remove carbon dioxide from a gas stream. Besides, carbon dioxide can also be removed by allowing it to mix with water and then condensing the same to remove the water vapour from the mixture. Some of the carbon dioxide runs off with water, therefore water must be treated before sending it into the environment. Carbon capture is carried out in gasifiers in three different methods: pre-combustion, post-combustion and oxy-fuel combustion.

- In the pre-combustion method, fuel is partially oxidized before its use. This facilitates almost pure emission of carbon dioxide when the fuel is burnt. The emitted carbon dioxide can be collected and sent for treatment immediately. This is commonly used for fertilizers and chemical gas fuel.
- The post-combustion method is used to collect the carbon dioxide emission from fossil fuels directly at a large point source.

- In the oxy-fuelling method, the fuel is burnt in oxygen instead of air. The resulting emission contains only carbon dioxide and water which can be separated through condensation and then sent to separate treatment plants.

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2. Vehicular Emission and Control

The increasing mobility of people around the world has led to enormous deterioration in the air quality, and the resultant air pollution has emerged as a major concern for human health. In the last few decades, harmful vehicular emissions have shot up exponentially due to the rising mobility of people. These emissions are a major cause of air pollution. These emissions arise because of two main reasons: one, the nature of fuel being used in vehicles and the technology of vehicles. Besides, the quality of traffic management also plays a crucial role in emission control and reduction. Efforts are being made to control the air pollution caused by vehicular emissions to provide clean air for the humans to breathe. The following sections describe some of these efforts related to use of new technology, such as catalytic converters, particulate traps and CNG engines.

Catalytic Converter

A catalytic converter is a device which is fixed in the exhaust of an automobile's emission system. The catalytic converter with the help of a catalyst carries out chemical reactions within the automobile to rid automobile emissions of gases or pollutants which are harmful to the environment, such as carbon monoxide, unburned hydrocarbons, etc. Vehicles with catalytic converters emit only carbon dioxide, nitrogen and oxygen. All these gases can be released into the environment in moderate quantities without any adverse effect. However, extremely high carbon dioxide emissions from vehicles are a new threat to the environment. Thus, techniques and technologies are being developed to reduce carbon dioxide emissions from vehicles.

The most common catalytic converter is a three-way device. It is named thus because it simultaneously carries out three different chemical reactions, each used to stop one particular harmful pollutant from entering the air. One oxidizing reaction converts carbon monoxide into carbon dioxide. Another oxidization process converts unburned hydrocarbons to water. And, the third reaction is a reduction reaction in which oxides of nitrogen are turned into nitrogen and then released into the air.

Particulate Traps

Particulate traps or particulate filters are used to reduce particulate or soot emissions from automobiles. These are particularly meant for diesel engines because diesel emissions result in soot formation which is harmful to the environment. Particulate traps reduce engine soot emissions by up to 80 per cent, thus making the engine emission cleaner and environment- friendly. In a diesel engine, when the combustibles run through the exhaust pipe, the particulate traps catch hold of the soot, stopping

its release into the environment. Since soot particles are large, the traps need to be cleaned regularly for good performance and for adherence to standard emission norms.

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The process of cleaning the particulate traps is called regeneration. In this process, the collected soot is heated to high temperatures to burn it off and turn it into ash which would not block the traps and ensure constant cleaning of the air. Regeneration is of two types: passive and active.

- In passive regeneration, a vehicle is fitted with a mechanism to heat up the gas enough to break down the soot.
- In active regeneration, a vehicle is sent for servicing and its exhaust is exposed to heat to break down soot into ash

If timely regeneration is not carried out, expensive repairs would be required. In such repairs, the exhaust would be opened and the trap would be replaced.

CNG Engines

Vehicles fitted with Compressed Natural Gas (CNG) engines are becoming more and more popular. A good number of vehicles today run exclusively on CNG, while some use CNG as an additional option along with petrol and diesel. One main reason of CNG popularity is its abundant availability. Besides, it is a natural, renewable source of energy which is cheaper and easily available to all. Governments in many countries have made it mandatory for public transport to use CNG engines only.

The biggest reason behind the popularity of CNG is the fact that it does not let out pollutants when it is burnt. In other words, CNG combustion is not injurious to the environment. Therefore, CNG vehicles' emissions do not need treatment before their release into the environment.

Though the CNG use is being encouraged worldwide, there are still a few disadvantages associated with it which need to be taken care of. For example, the tank required for CNG storage is heavy and bulky even in comparison to LPG tanks which use a huge amount of space. Also CNG refuelling is not convenient because its distribution infrastructure is still in a state of development.

3. Air Quality Management Plan for a Region

An Air Quality Management Plan (AQMP) is a set of sub-plans which are laid out periodically for defining new standards to be met by using technology to improve the environment quality. AQMPs are region-specific, as they take into account the deterioration in the air quality of a region and focus on the techniques which could prove useful for that region. These plans integrate the efforts of central and state governments to enforce new standards legally and also supplement the efforts of different industries to help them adhere to high standards of emissions. An AQMP for a region deals with the following region specific aspects of the environment.

Air Quality Monitoring

Air quality monitoring is carried out using a measuring tool known as the Air Quality Index (AQI). This index measures emissions and the presence of particular pollutants on a scale of 0-100 to judge air quality. On this scale, the range 0-15 represents the benchmark for the lowest pollution level, that is, the lowest amounts of pollutants present in the air, and thus the highest level of air quality. The value 100+ indicates alarming levels of the pollutants present and thus low air quality. AQI is used to measure the following six main pollutants:

- Ozone
- Fine particulate matter
- Nitrogen dioxide
- Sulphur dioxide
- Carbon monoxide
- Total reduced sulphur compounds

Emission Inventory Study

This study focuses on the source of emission as well as the method of managing the emission. Knowing the emission source would help one come up with suitable techniques to combat high emission levels, reduce them and even eradicate them altogether. This study is used to adequately represent the presence of pollutants in the air and measure the time of their presence in the air. It also sees how the pollutant levels have changed with time and how the applied solutions or techniques have been able to bring about these changes. The simulations and models, used in the emission inventory study, are also used to depict the possible amount of air pollution in future depending on the increase or decrease of the source it comes from. This helps prepare the environment as well as people for the speculated change.

Health Impact/Study

The health impact study focuses on building of models for speculating and assessing the health issues that the population would be subjected to in future because of increase in the amount of air pollutants. The World Health Organization (WHO) organizes a similar study, called Health Impact Assessment (HIA), which takes into consideration the deterioration of health standards with the deterioration of the environment. HIA encourages individuals, institutes and government bodies to take initiatives for bringing about substantial changes so as to prevent the speculated health impacts.

Emission Control Strategy Update

Emission control strategies need to be dynamic in nature and must have potential to combat new and revised forms of pollution emission. With the advent of every

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new technology, the emission system changes itself and often becomes immune to emission control measures, thus destroying the environment. Therefore, emission control strategies need constant upgrading and revision to cope with new forms of emission. Also, new chemical reactions resulting from the use of a new technology may lead to new chemical formations, which could prove deadly for the atmosphere. In this case, one must come up with suitable alternative techniques to reduce those emission impurities in the atmosphere or control them at the source itself, which cause harmful chemical reactions. With every upgrade in an emission control strategy, we ensure a better future for ourselves as well as the environment.

Cost–Benefit Analysis

Cost–benefit analysis is a study to weigh the financial rewards expected from an AQMP against the cost to be incurred on it. This analysis takes into account all the factors which would require financial outgo and then speculates a result that how the project would prove to be beneficial financially in the long run. Looking through the financial success of alternative strategies and plans is a part of the cost–benefit analysis. This is done to arrive at a plan which would be most suitable according to the situation and resources available in a particular region.

Institutional Mechanism

This part of an AQMP addresses the need of setting up institutions to monitor the plan implementation. These institutions would be designed particularly to have a comprehensive look into the working of the plan, analyse its success at all levels and then suggest changes to higher authorities for the same. The number of institutions needed as well as the kind of training and education required for the employees of the proposed institutions comes under this section of the plan. Having the right staff to monitor the success or failure of the plan would prove to be a great help in bringing timely improvements in the plan. If the staff involved is not interested or does not have full understanding of the importance of the plan, , they would not be able to appreciate its success or account for its failure.

Check Your Progress

7. What are volatile organic compounds?
8. What is AQI?

9.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Water pollution can be defined as an alteration in physical, chemical or biological characteristics of water, making it unsuitable for the designated use in its natural state.

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2. The major sources of surface water pollution are: sewage, industrial effluents, synthetic detergents, agrochemicals, oil and waste heat.
3. Pathogens are disease causing microorganisms which grow and multiply within the host.
4. Heavy metals are referred to as metals with specific gravity greater than about 4 to 5.
5. Wastewater treatment methods are practices followed to purify the polluted water from an industry before it is disposed of into a large water body.
6. The main objective of wastewater reuse is to find economic and environment-friendly alternatives to meet the present demand for water without compromising with the nature's need for maintaining a certain amount of clean water as well.
7. This class of compounds are unburnt hydrocarbons (fossil fuels not completely combusted) that enter the atmosphere when solvents, fuels and other organics evaporate.
8. Air quality monitoring is carried out using a measuring tool known as the Air Quality Index (AQI). This index measures emissions and the presence of particular pollutants on a scale of 0-100 to judge air quality.

9.5 SUMMARY

- Water pollution can be defined as an alteration in physical, chemical or biological characteristics of water, making it unsuitable for the designated use in its natural state.
- Pollution of water can be caused by point sources or non-point sources. Major point sources of water pollution are industries, power plants, underground coal mines, offshore oil wells, etc.
- Water that is found in nature is called natural water. The natural water (sea water, rivers, lakes, polar ice and glaciers) contains numerous organisms like phytoplankton, zooplankton, fish and many other things. Water contains dissolved gases like oxygen, essential for aerobic aquatic organisms, carbon dioxide for small plants to bloom so as to be utilized by aquatic animals.
- Pathogens are disease causing microorganisms which grow and multiply within the host. The resulting growth of microorganisms in a host is known as infection. Water is the carrier of such pathogenic micro-organisms, causing immense harm to public health.
- Nutrients are chemicals essential for the growth of living things. For plants there are sixteen elements required for their healthier growth. They are carbon, hydrogen, oxygen, (obtained mainly through CO2 and water from

the soil), nitrogen, phosphorus, potassium, calcium, magnesium, sulphur and micronutrients such as iron, cobalt, manganese, boron, molybdenum and copper.

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- Heavy metals are referred to as metals with specific gravity greater than about 4 to 5. The most important heavy metal pollutants are mercury (Hg), lead (Pb), cadmium (Cd) and arsenic (As).
- The word eutrophication is originated from Greek words *eu* = 'well' and *trophes* = 'food'. Thus, it means 'well fed' or 'nutrient rich'. So, we can define eutrophication as excessive nutrient load in a water body or enrichment of water body by nutrients.
- Eutrophication is a natural process and may take thousands of years. However, this is greatly enhanced through human activities and is termed as accelerated or cultural eutrophication. The industrial wastes, municipal waste water, run-off from agricultural lands, provide plenty of phosphates, nitrates and various minerals stimulating algal growth.
- Wastewater treatment methods are practices followed to purify the polluted water from an industry before it is disposed of into a large water body.
- Primary treatment is restricted to separation of large impurities only because small particles take too long to settle. Smaller particles are removed by other processes.
- In the secondary treatment of wastewater, organic impurities are removed through aerobic treatment.
- Advanced treatment is used to remove any impurities left in the water after primary and secondary treatments and to alter the mineral or nutrient content of the water.
- Eco-friendly methods of water pollution management use resources from the environment for water decontamination. Eco-friendly methods combine human efforts with the environment's cleansing capabilities to decontaminate wastewater.
- Maintenance of wastewater involves taking preparatory steps to ensure its proper treatment. This initial stage includes removal of large impurities from the water which can simply be picked off using a large sieve.
- The terms 'wastewater reuse', 'wastewater recycling' and 'wastewater reclamation' are used synonymously. The main objective of wastewater reuse is to find economic and environment-friendly alternatives to meet the present demand for water without compromising with the nature's need for maintaining a certain amount of clean water as well.
- 'Air pollutant' means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be

injurious to human beings or other living creatures or plants or property or environment. Air pollution means the presence in the atmosphere of any air pollutant.

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- The natural sources of air pollution are volcanic eruptions, forest fires, sea salt sprays, biological decay, photochemical oxidation, extra-terrestrial bodies, pollen grains of flowers, etc.
- The most important indoor air pollutant is radon gas. This is responsible for a large number of lung cancer deaths each year. These could be emitted from building materials like bricks, concrete and tiles.
- Carbon dioxide absorbs infrared radiations to keep the earth warm. Thus, troposphere controls the weather conditions.
- The major cause of air pollution is the result of emissions of high concentrations of sulphur oxides, nitrogen oxides, carbon oxides and particulate matter. The excessive amount of sulphur oxide and nitrogen oxide is due to the burning of fossil fuels, especially coal used in power plants.
- This class of compounds are unburnt hydrocarbons (fossil fuels not completely combusted) that enter the atmosphere when solvents, fuels and other organics evaporate. The decomposition of organic wastes and garbage also produces hydrocarbons.
- To control or eradicate particulate air pollution, certain systems or technologies are installed in the technology infrastructure of industries. These systems are referred to as particulate air pollution control systems. These systems consist of large and small air purifiers which clean industrial gaseous emissions before they are released into the atmosphere thus preventing any environmental damage.
- Settling chambers are large containers which are used to separate coarse particulate matter from the air to reduce its pollution.
- Electrostatic precipitators are devices that use electricity to separate particulate matter from a stream of gas. In an electrostatic precipitator, a gas stream is pushed through electrical charges.
- The various techniques used for gaseous control are: absorption, adsorption, biological treatment, oxidation, reduction, condensation.
- The catalytic converter with the help of a catalyst carries out chemical reactions within the automobile to rid automobile emissions of gases or pollutants which are harmful to the environment, such as carbon monoxide, unburned hydrocarbons, etc.
- The biggest reason behind the popularity of CNG is the fact that it does not let out pollutants when it is burnt.

NOTES

- An Air Quality Management Plan (AQMP) is a set of sub-plans which are laid out periodically for defining new standards to be met by using technology to improve the environment quality. AQMPs are region-specific, as they take into account the deterioration in the air quality of a region and focus on the techniques which could prove useful for that region.
- Emission control strategies need to be dynamic in nature and must have potential to combat new and revised forms of pollution emission. With the advent of every new technology, the emission system changes itself and often becomes immune to emission control measures, thus destroying the environment.

9.6 KEY WORDS

- **Eutrophication:** It is a limnological term for the process by which a body of water becomes progressively enriched with minerals and nutrients.
- **Emission:** It is the production and discharge of something, especially gas or radiation.
- **Air Quality Index:** It is an index for reporting air quality on a daily basis. It is a measure of how air pollution affects one's health within a short time period.

9.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Which factors are responsible for water pollution?
2. How can we control water pollution from non-point sources?
3. Under what circumstances do the nutrients that are essential for the growth of living beings become pollutant?
4. What are the sources of air pollution?
5. Name natural and man-made sources of air pollution.
6. What are the effects of air pollution?

Long-Answer Questions

1. Illustrate the wastewater treatment methods.
2. Discuss the sources and effects of various criteria pollutants.
3. Explain the systems or technologies used in particulate matter removal.
4. How is Air Quality Management Plan (AQMP) carried out? Explain.

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UNIT 10 ENVIRONMENTAL THREATS-II

NOTES

Structure

10.0 INTRODUCTION

Sound is an important and valuable part of everyday life. But when sound becomes noise, it can negatively affect our mental and physical health. The realities of modern life mean the noises created in our world are not going to suddenly fall silent. Instead, we need to recognise that noise pollution is a serious health concern worthy of our attention, and find realistic and sustainable ways to manage and reduce it. Exposure to prolonged or excessive noise has been shown to cause a range of health problems ranging from stress, poor concentration, productivity losses in the workplace, and communication difficulties and fatigue from lack of sleep, to more serious issues such as cardiovascular disease, cognitive impairment, tinnitus and hearing loss. Another persisting issue which authorities find difficult to tackle with is solid waste management. We will discuss three methods of solid waste management, namely landfill, incineration and composting in this unit along with noise pollution.

10.1 OBJECTIVES

After going through this unit, you will be able to:

- Describe the meaning and causes of noise pollution
- Explain the control measures to reduce the noise levels
- Discuss the methods of solid waste management

10.2 NOISE POLLUTION

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Noise is an unwanted, irregular, unpleasant and annoying sound, *i.e.*, sound with no musical quality. The definition however, is subjective because one man's sound may be another man's noise. Noise can thus be defined as 'wrong sound, in the wrong place, at the wrong time'. However, it is always true that if the sound is loud and it prolongs for a longer period of time, it becomes noise for all. A given sound is pleasant when soft, but noisy when loud, pleasant when rhythmic, but noisy when repeated randomly. The word 'noise' comes from the Latin word *nausea* meaning 'seasickness' or from a derivative of Latin *noceo* = 'I do harm'.

Whereas sound is a pure tone, harmonically related, occurring at regular intervals and produces meaningful communications, noise is a complex mixture of a number of pure tones of varying frequencies and amplitudes.

Sound is a form of invisible energy, generated by a vibrating object and requires an elastic medium, which may be gas (air), liquid (water) or solid (metals, plastics, etc.) for its propagation, as it comprises wave motion. Sound waves are longitudinal waves, because the medium particles have periodic changes in displacement and pressure in the same direction of the waves.

A loudspeaker diaphragm which moves to and fro generates sound. As the diaphragm moves forward, it compresses the air near it. Now, due to the forces developed by this compression, the air further away is progressively set in motion as the inertia of the air molecules is overcome. Now when the diaphragm reverses its direction of motion, it produces a rarefaction of air near it and a movement of the air molecules further away occurs progressively in the opposite direction. Thus, simultaneous compression and rarefaction set in, leading to pressure changes and we get sound.

The poor elasticity of air causes the disturbance (the pressure variation) which causes sound to travel at a slow speed of around 330 ms–1. The extent of disturbance depends upon the rate of vibration of the vibrating object, the dissipative losses in the air molecules, the pressure of wind, temperature gradient and turbulence on the boundary surfaces.

Noise pollution can be defined as the unwanted sound dumped into the environment, unwanted due to the adverse effects it may have in relation to physical and mental health, displeasing effect, human communication, etc.

The unit of sound intensity is decibel (dB). Generally, the sound intensity from 0 to 100 dB is considered to be pleasant, but when the intensity exceeds 120 dB, it causes noise. Sound intensity of 130 dB is the upper limit of hearing and beyond this is the threshold of noise, causing pain to ear. The sound more than 130 dB causes noise pollution. However, the sound intensity received by the ear will be noise or not, depends on the distance, the listener is from the source and for how long he hears it. The distance is taken as one meter and time varies from person to person.

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Mechanism of Hearing (Human Acoustics)

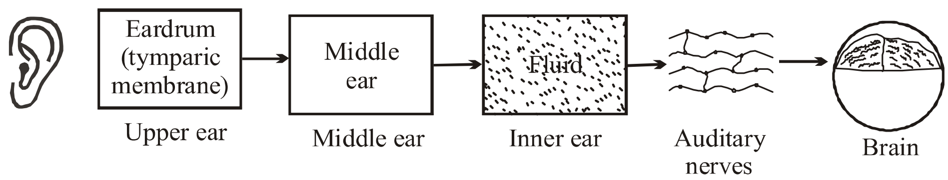


Fig. 10.1 *Human acoustics*

The science of human hearing sound is called human acoustics. Human acoustics specifically indicates the different processes that are involved in the perception of some sound by our ears.

Sound waves set up oscillations in the eardrum made up of tympanic membrane in the upper ear. The oscillations in the eardrum induce movements of the three small soft bones in the middle ear behind the eardrum.

The movements or oscillations in the middle ear pass through viscous fluid in the inner ear, creating oscillations of the fluid. These oscillations then reach the auditory nerves and are finally transmitted to the brain.

The oscillations or sounds are identified and interpreted in the brain, which has the capacity to analyze sound into different frequency components.

Human detectable frequency ranges are 2 to 20,000 Hz.

An eighteen year old person, with normal hearing, has audio range between 20 to 20,000 Hz. The audio sense is most sharp in the frequency range of 2000 to 5500 Hz.

Sensitivity of the ear varies from person to person. With ageing, hearing power decreases progressively. The ear is susceptible to damage if it receives high intensity noise. However, the ear has some natural protective device for short durations.

Intensity

Two important parameters of sound are sound pressure and intensity. They are measured in different units of different magnitudes. The common unit is decibel (dB). It is not an absolute value like kilogram, second, meter, etc., it is a ratio expressed in terms of logarithmic scale and is mathematically given as

$$\text{decibel (dB)} = 10 \log_{10} \frac{\text{I(measured intensity)}}{\text{I}_0\text{(reference intensity)}}$$

Thus, decibel measures how much intense is the sound compared to reference intensity. Human beings can receive a vast range of intensities from around 1 × 10–12 W/m2 to 1000 W/m2.The reference intensity I0 is taken as 1 × 10–12 W/m2 , which is considered to be an intensity level just audible to man. This, thus can be said to be threshold of hearing. Unfortunately, there are practical difficulties in accurately measuring intensity. However, it is relatively easy to measure

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the consequence of the energy passage and the pressure variation. Since the intensity is directly proportional to the square of the pressure, that is

$$I_0 \propto P_0^2 \quad \text{and} \quad I \propto P^2$$

The sound pressure level (*SPL*) in *dB* is defined by

$$\text{SPL} = 20\log_{10}(\frac{P}{P_0})\text{dB}$$

where, *P* is the measured pressure in Nm–2 and *P0* the reference pressure, usually equals to 2 × 10–5 Nm–2 and is the nearest whole number corresponding to the reference intensity. Sound pressure level (SPL) or sound level is thus, the logarithmic measure of the RMS value of sound pressure of a sound relative to a reference value.

Measurement of Noise Levels

Noise level in decibel is measured with an instrument called sound level meter. It consists of three internationally accepted weighting networks, namely *A*, *B* and *C*. Noise level measured with network *A* is designated as dBA. In this scale, the frequencies to which human beings are more sensitive are given more weightage, in the assessment of effects on human hearing.

Noise surveys must be made in the entire area for evaluation of overall noise level and in the vicinity of individual noise sources under different environmental conditions. The noise emitted by individual sources must be carried at specified distance.

The disadvantage of dBA scale is that it is not related to human ear frequency response as well as environmental conditions, on which noise is measured. In case of dBA scale, although it is a characteristic of human ear capacity, it does not take account of peak noise levels, duration of noise and its quality. Therefore, other scales of measurement of noise levels with proper refinements of dBA scale are done. These are:

L10 (18 hours) Index

It is the arithmetic average hourly values of the noise level exceeded for 10 per cent of the time over 18 hours between 06:00 and 24:00 hours on any normal week day. This scale is used to measure road traffic noise in the UK. This scale of measurement considers peak noise level, fluctuation of noise due to nature of vehicle and traffic density.

Equivalent Perceived Noise Level (Lepn)

It is the noise level measured in dBA scale and the value is taken to be (dBA scale +13). *Lepn* is used for measuring noise level of aircraft, recommended by International Civil Aviation Organization (ICAO). The measurement takes care of both the peak frequency of the aircraft and duration of flyovers.

Equivalent Noise Level (Leq)

It is the weighted average sound level over the time of measurement and is represented as *Leq* and given in dBA unit. The time of measurement is specific and measured for a short duration usually when the noise level is most prominent. If the measurement is done for different time durations the value will differ. If the measurement is done for a specific period of time started at the same time but in different place, it may not be same. Equivalent noise level is accepted by International Organization for Standardization (ISO). *Leq* is used for measurement of noise level in the industrial, traffic as well as residential areas.

Noise Classification

Noise may originate from natural sources as well as through anthropogenic activities. The natural sources are cyclone, thunder, roaring of sea, volcanic eruption, etc. The anthropogenic sources are heavy machineries used in the industry, mechanized automobiles, trains, aeroplanes, washing machine, television, etc. The anthropogenic noise can be classified into

(*i*) Transport noise

(*ii*) Occupational noise

(*iii*) Neighbourhood noise

(i) Transport Noise

For simplification, transport noise is subdivided into three categories:

(*a*) Road traffic noise (*b*) Rail traffic noise (*c*) Aircraft noise

(*a*) *Road Traffic Noise*: The main causes of road traffic noise are the number of road vehicles and their high traffic speed. Heavy vehicles with faster speed create the maximum noise on the road. For example, heavy diesel engine trucks are the nosiest vehicles. All around the world, the traffic peak hour is from 10:00 a.m. in the morning to 6:00 p.m. evening. The traffic noise level is measured on the *L*10 (18 hours) index. The limit of noise level prescribed in India is 80 dBA, but is never followed. (*a*) *Road Traffic Noise*: The main causes of road traffic noise are the number of road vehicles and their high traffic speed. Heavy vehicles with faster speed create the maximum noise on the road. For example, heavy diesel engine trucks are the nosiest vehicles. All around the world, the traffic peak hour is from 10:00 a.m. in the morning to 6:00 p.m. evening. The traffic noise level is measured on the *L*10 (18 hours) index. The limit of noise level prescribed in India is 80 dBA, but is never followed.

(*b*) *Rail Traffic Noise*: It is not that serious like road traffic noise and aircraft noise. The noise is of lower frequency compared to road traffic noise. Introduction of diesel or electrical engines in place of steam engine, welded tracks and improved coaches has contributed a lot in reducing noise.

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Moreover, most railway tracks run through rural areas which are wider places surrounded by plants and trees. However, buildings located near railway tracks are exposed to noise menace. The rail traffic noise is measured on *Leq* scale.

(*c*) *Aircraft Noise*: Aircraft noise is not created continuously but is intermittent. The noise is produced during takeoff, landing and flight. The faster and larger the aircraft, the more is the noise and thus, jet engines create the most noise. Although lesser in number, the aircrafts like fighter aircrafts which fly supersonically, become the noisiest source. The aircraft noise level is measured in *Lepn* scale (dBA scale +13).

(*ii*) Occupational Noise

This is mainly produced by industrial machines and processes like blasting operations, shipbuilding, factories and mills producing different kinds of products. Occupational noises are also due to machines used for domestic purposes such as television, washing machines, vacuum cleaners, etc. In industries, factories or mills, the workers are exposed for five days with 8 hours per day. In their houses, they are getting exposed for a longer duration, although frequency is lower compared to industry and factories. Millions of people working in industries are the main victims. The high degree of noise causes lowering of hearing capacity to a great extent.

Table 10.1 *Some Industrial Noise Levels*

Industrial source	*Noise Level (dBA)*
Steel plate riveting	130
Boiler marker's shop	120
Farms tractor	103
Newspaper press	101
Milling machines	82

(*iii*) Neighbourhood Noise

There is a variety of sources of noise that disturb and annoy people by interfering with their comfort. The sources are loud TV, stereo, radio sets, barking of dogs, garaging the automobiles, starting of the two wheelers used by people, without considering the harmful effects which they might have on the nearby neighbours. The use of machines for building construction and building demolition are also sources of serious nuisance. Use of loud speakers at public functions, in disco music and dance in late evenings also causes noise nuisance to the nearby residents.

The prescribed permissible sound level for cities by Central Pollution Board of India is given below in table 10.2.

Table 10.2 Permissible Sound Level

Area	*Day (dBA)*	*Night (dBA)*
Industrial	75	65
Commercial	65	55
Residential	50	45
Educational Institution, courts, hospitals (most sensitive area)	50	40

10.2.1 Effects of Noise Pollution

Let us discuss the effects of noise pollution.

Physiological Effects

(*a*) **Acute effects:** Such effects by noise depend upon the pressure and frequency. As is known, a sound of 65 (dBA) is the noise level for conversation heard at a distance of one meter. Sound of 110 (dBA) gives discomfort and 135 (dBA) is painful and 150 (dBA) might kill a person. A sound level in the range of 110–150 (dBA), affects respiratory system, causes loss of physical control and other physiological changes might occur.

Loud sounds can cause an increased secretion of various hormones of the pituitary gland, leading to increased blood sugar level, reducing immune system capability, effecting liver, heart, brain and kidney.

(*b*) **Chronic effects:** The major effect is hearing loss. A person exposed to high noise levels goes deaf more quickly compared to the person exposed to relatively noise free environment. Such effects depend on pressure, frequency and period of exposure. The hearing loss starts in the frequency range of about 4000 Hz.

Mental Health

Noise affects mental capability, thereby reducing mind concentration and at higher frequencies leads to mental disorientation.

Work Efficiency

Noise causes chronic headache and irritability, thereby reducing work efficiency.

Industrial Accidents

Noise interfering with sound system might mask the warning signals, thereby increasing the incidence of errors making accidents more likely.

Communication

The sound signal is distorted if the frequency of noise coincides with it. Thus, we have to raise the volume of our TV set or radio set to overcome the interferences of noise frequency, thereby creating further noise.

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Personal Comfort

To maintain a healthy body and a healthy mind, one needs a minimum specific period of proper sleep. Noise may contribute to distress and emotional disturbance. This effect is more severe on old people and children. For old people it might cause neurotic problems and for children, it might affect their behavioural pattern.

Effects on Birds

Migratory birds are now found to be the victims of noise pollution. The high noise pollution, along with high-rise buildings around a place can reduce the number of migratory birds. Such an effect is already observed in Alipore Zoo in Calcutta. Whereas, the number of migratory birds was 15,000 in 1982 it became 2,000 in 1990.

Table 10.3 *Psychological and Physical Effects of Noise*

Noise Level (dBA)	*Effects*
135	Painful
110	Discomforting
80	Annoying
65	Heard at a distance of 1 meter
150	Significant change in pulse rate
160	Minor damage of hearing
190	Major damage in a short time

Noise Threshold Limit Values

The noise threshold limit values as per the American National Standard Specification of sound level meters, SI (197) TYPE 52*A*, is given in the table 10.4.

Table 10.4 *Noise Threshold Limit Values*

Duration Per Day (Hour)	*Sound Level (dBA)*
16	80
8	85
4	90
2	95
1	100
½	105
¼	110
1/8	115

When daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect needs to be considered rather than the individual effect of each. When the sum of following fractions exceeds unity, then the mixed exposure is considered to exceed the threshold limit values. *Cn* indicates

the total duration of exposure at a specific noise level and *Tn* indicates the total duration of exposure permitted at that level.

$$\frac{C_1}{T_1}+\frac{C_2}{T_2}+......\frac{C_n}{T_n}$$

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Impulsive or Impact Noise

There are some recommended threshold limit values of impact or impulsive noise levels. For time intervals, greater than one second is considered as impulsive or impact noise and less than one second as continuous. Exposure to more than 140 dBA peak sound pressure level is never permitted.

Table 10.5 *Threshold Limit Values having Impulsive or Impact Noise*

Sound Level (dBA)	*Permitted Number of Impulses or Impact Per Day*
140	100
130	1,000
120	10,000

Monitoring

It is very essential to monitor environmental conditions continuously to minimize the risk of noise exposure. The long-term program undertaken to see that the measured noise level does not vary and protective action taken remains effective, more preventive measure can be introduced when necessary. For better confirmation, medical examinations of workers can ascertain whether the preventive action taken has proved satisfactory or not.

10.2.2 Noise Control

The noise generated in the environment can never be eliminated completely, however, it can be controlled. Many new technologies are introduced to curb noise. There are, however, some easy ways to curb noise besides introduction of new technology. The basic difference of noise pollution from other types of pollution is that it does not leave any residue in the environment, but it creates enormous physical and mental health problem in persons continuously exposed to it for a considerable time. As we cannot see the sound wave and as it does not leave any residue, it is not given that importance and people are continuously exposed to it. Thus, it is the demand of the hour to implement new stringent laws, such as motor vehicle act, introduce new regulation to lower speed limits of vehicles, promote education and research creating awareness among the public about the harmful effects of noise pollution through radio, television and newspapers.

The noise created from the heavy machinery used in the industry as well as other community can be curbed by taking measures at the source, at the noise transmission path and at the receivers. Source is the main route of noise generation.

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If noise is completely abated at the source the other two need less nourishment. However, due to various machinery parts involved in the source, noise cannot be abated completely. So if we take care of the three areas all together, noise can be eliminated to a maximum level.

(a) Control at Source

In the industrial establishment, it can be done by proper design, proper operation and regular maintenance of the machines. The industry should be located at open spaces far off from the residential areas.

As far as community noise is concerned, the loud speakers, radio and music system should not be allowed to cross the threshold intensity.

(b) Control at Path

The noise transmission path can be covered with such material, which can absorb the sound, can insulate the sound. Sound absorbers can be glass wool, porous panels, perforated panels, tiles, carpets, curtains, etc. These materials are generally porous which reduce reflection of sound.

Sound insulators reduce sound transmission through barriers. Sound insulating materials could be glass, steel, ceramic materials, concrete, etc.

Vibration control of the machinery is generally done by mounting the machine on a base plate or an inertia block like concrete block.

The various other measures of path control resources are:

(*i*) ***Acoustic enclosures*:** This can be done by putting close fitting enclosure around the machine, keeping high noise generating machine in a separate room at a relatively long distance. The walls of the enclosures are also made with acoustically lined materials, such as glass fiber or fiber wool inside the wall.

(*ii*) ***Noise barriers*:** This can be done by constructing walls with hard and dense materials to reflect sound or porous material to absorb sound and by placing them closest to the noise source. To achieve high degree of efficiency, the gaps or the joints of barriers are eliminated, so that the sound does not leak through and reduce efficiency. However, sound will lead the machine operator to get exposed to the noise. Some common examples of noise barriers are glass fibers, brickwork, fiberboard, etc.

(*iii*) ***Silencers*:** Silencer is a hollow material, shaped in such dimensions that it reduces sound transmission, but allows the gases (incoming as well as outgoing) to pass through it. The silencer may absorb the sound or reflect the sound or if designed properly can function in both ways in a single system, thereby reducing noise intensity.

The materials generally used are stainless steel, tin plate, stainless iron which acts as a reflector of sound and when coated with fiberglass the

sound intensity reduces to a large extent due to the absorption of sound. Silencers are generally used in automobiles and transport vehicles.

(*iv*) ***Reduction of noise produced due to vibration of machine***: Installation of a machine on the floor contributes to high noise pollution to a large area around it. The best way to solve such problem is to place the machine on a thick steel plate, isolated from the other by a thick block of rubber.

(*c*) Control at Receiver (Personal protection)

No matter how much precaution be taken, how much technology is introduced, it is not possible to nullify noise. Thus, personal protection is very essential for the safety of the workers. For such cases, ear protection and in extreme cases personal isolation will help a lot. The commonly used hearing protectors are earplugs, ear muffs, etc.

In an extreme case, the person can be isolated from the source to stay in an air conditioner enclosure or a thick walled sound absorbing room, with a viewing window and occasionally, can go to the operating room thus, minimizing noise exposure. In an industrial establishment, administrative control helps a great deal. The workers should be given shift duties, so that an individual or groups are not exposed to the noise for a longer period of time.

Lastly, it should be mentioned that plants and trees have a greater capacity for reduction of noise. Plants are efficient absorbers of noise, especially noise of high frequency. Thus, plantations along highways, streets and industrial areas should be done. This is one of the reasons due to which rail traffic noise or other road transport noise is less when they run through highways having green plantation on both sides. Air traffic noise can be curtailed by growing green vegetation belt of short to medium height around the airport.

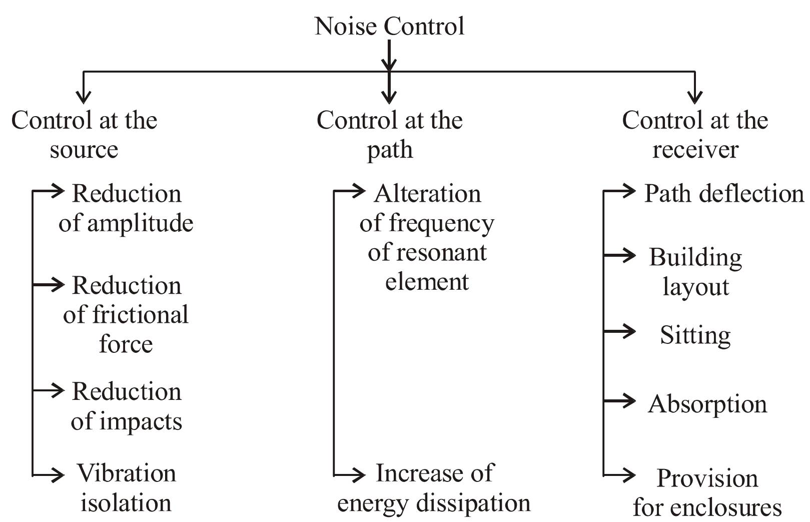


Fig 10.2 *Noise Control*

Prevention of Noise Pollution

Noise pollution has harmful effects on both our body and mind. The safe intensity level of sound, as prescribed by World Health Organization (WHO) is 45 dB. But in the present era, it is rarely maintained and the result is 'Noise Pollution'. In order to lead a healthy life, abatement of noise pollution should also be considered seriously. The various sources of noise pollution are road traffic noise, rail traffic noise, aircraft noise, industrial noise and neighbourhood noise, etc. There are a variety of effective strategies for abating noise levels, such as use of noise barriers, limiting vehicle speeds, improving tire design, limiting heavy duty vehicles and use of silencers in the vehicles for road traffic noise, designing quieter jet engines, altering flight paths for aircraft noise, improving technology for electric locomotives for rail traffic noise, redesigning of industrial equipment, using acoustic screens and barriers for industrial noise. One of the best ways of reducing noise pollution is through making green belt around the residential areas, around airport and on the sides of the road where the vehicles and trains run.

Besides all the above measures, following steps should be followed to prevent noise pollution to the highest extent.

- raising public awareness about the effect of noise pollution.
- distributing up-to-date information regarding noise pollution.
- strengthening laws and governmental efforts to control noise pollution.
- establishing networks among environmental professionals, governmental and all other activist groups working on noise pollution issues.
- helping and protecting activists working against noise pollution.

Lastly, it can be mentioned that two very simple measures can help a lot in abating noise pollution.

The cities can be developed in a planned manner. Industry and transport areas can be separated into zones, residential areas may be made at least 20 meters away from the main streets and the space be thickly planted. Heavy vehicles should not be allowed to use narrow streets and the use of horns and pressure horns be prohibited.

Check Your Progress

1. Define noise pollution.
2. How much sound intensity causes noise pollution?
3. What do you mean by human acoustics?
4. What are the two important parameters of sound?

10.3 LAND DEGRADATION

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Because of increase in population, the demand for arable land for producing food and fuel wood is also increasing. Hence, there is more and more pressure on the limited land resources which are being depleted due to overexploitation. Soil erosion, waterlogging, salinization and contamination of the soil with industrial wastes like fly ash, press mud or heavy metals all cause degradation of land.

Soil erosion: Soil erosion means wearing away of soil. It is defined as the movement of soil components, especially surface-litter and top soil from one place to another. It results in the loss of fertility.

It is basically of two types, viz, normal erosion or geological erosion and accelerated erosion. The agents that cause such erosions are climatic agents and biotic agents.

Wind is also responsible for land erosion through saltation, suspension and surface creep.

In order to prevent soil erosion and conserve the soil, the following conservation practices are employed:

- Conservational till farming
- Contour farming
- Terracing
- Strip cropping
- Alley cropping
- Wind breaks or shelterbelts
- Waterlogging

Landslides: A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity. Various anthropogenic activities like hydroelectric projects, large dams, reservoirs, construction of roads and railway lines, construction of buildings and mining are responsible for clearing of large forested areas.

Desertification: It is a process whereby the productive potential of arid or semiarid lands falls by ten per cent or more. Desertification is characterized by devegetation and loss of vegetal cover, depletion of groundwater, salinization and severe soil erosion. The causes of desertification are deforestation, overgrazing and mining and quarrying.

It should be kept in mind that land degradation can occur due to landpollution, urbanization, poor forming practices and many other reasons. In this section, our focus will be only on one aspect that is, land pollution due to solid waste problem.

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10.3.1 Land Pollution due to Solid Waste Problem

The quantity of solid wastes generation in big cities of India is almost 400-600 gm per person and is increasing day by day at an enhanced rate. Again, due to high illiteracy, indiscipline and carelessness in our basic character, we prefer to throw the waste in the street rather than collection and proper disposal. We never think about the consequences of such things at all. These wastes, either alone or under prevalent conditions, can combine with other secondary wastes creating high degree of health hazardous problem. As far as municipal solid waste is concerned, the vegetables, leaves and fish remnants are the major constituents.

The biological decomposition of vegetable wastes, fish remnants and the dead animals release hydrogen sulphide (H_2S) and many other organic-sulphur gases, creating objectionable odour. The garbage is an ideal place for flies, mosquitoes, insects, rats and other rodents to live in. They live, grow and reproduce in garbage. Mosquitoes bring diseases like malaria, filaria and enchephalities. The flies carry contaminated food from the garbage and finally to human beings, causing dysentery, diarrhea, etc. Rats cause plague, leptospirosis, tularemia, trichinosis, and many more diseases. The open burning or fire generation due to organic decomposition may lead fire to continue for a longer period and may cause high degree of water and air pollution due to the release of leachable toxic materials into water, exerting oxygen demand and other pathogen along with noxius gases, creating health hazard problem. Again the workers handling the garbage are directly affected with roundworm and whip-worm.

Hence, disposal of solid wastes needs special attention. It is only through scientific, disciplined and effective solid waste management, that the four problems can be minimized or abated to the maximum possible extent. The present day management follows: (1) collection (2) storage (3) transportation (4) recycling (5) treatment (6) disposal.

Collection

At present there is an organized door to door collection system. This practice was not followed in an organized manner previously, causing dumping of garbage in the open spaces and streets causing insanitary conditions. However, it cannot be said that the collection system has efficiency of hundred percent. Sometimes, on Sunday, people do not collect the garbage, creating unhygienic condition at home and force people to throw the garbage into the open space and street. The road sweepers still sometimes burn or throw the garbage into open spaces. All these matters need special consideration.

Storage

Storage facilities, although have been developed significantly, we still require more storage. At the same time, the garbage should not be stored for a prolonged time, otherwise it can cause unhygienic conditions.

Transportation

The garbage is nowadays, collected frequently from the storage and transported to places far away from the community. However, many problems still remain. The trucks are found to be overloaded and the garbage spills creating foul odour. Many times, the drivers throw off the loaded garbage in nearby open space.

Recycling

We all know that all wastes are not complete waste. Proper recycling can generate materials of use. In India, a proper recycling process has not been achieved yet. There still exists door to door collection, collection from disposal sites, from collection bins by the people from the weaker section of society. These people store these materials in slum for prolonged time causing insanitary conditions. Moreover, they clean the materials in their water resources causing greater degree of water pollution.

Generation of waste can be minimized and the generated waste can be converted to wealth with the help of four *R* principle of waste management. The four *R* principle stands for: (1) Refuse (2) Reuse (3) Recycle (4) Reduce.

Refuse: Buying of new containers should be refused. The same containers in the house can be used again and again.

Reuse: Waste generated from home may not actually be waste. So items like cans, glass, bottles, should not be thrown away, instead they can be used as flower vase, pencil and pen stand, after proper decoration. Instead of plastic bags, if jute or cloth bags are purchased, they can be used again and again. All these lead to reduction in waste generation.

Recycle: The used and discarded wastes contain valuable materials like aluminium, steel, glasses, etc. During the recycling process, the wastes are collected, materials are processed and newer products are generated. Before recycling, the wastes are segregated to separate out biodegradable wastes from non-biodegradable waste. The biodegradable waste, such as household garbage, leaves, flowers, fruits from gardens can be used in compost pit and used as fertilizers. The non-biodegradable waste such as plastics, glass, paper, bulbs, pesticide containers, batteries, again can be segregated to separate toxic waste from non- toxic waste. The non-toxic waste can be recycled for reuse and toxic wastes can be disposed of. Recycling thus, reduces environmental pollution to a greater extent as well as saves money as lesser amount of newer materials need to be generated.

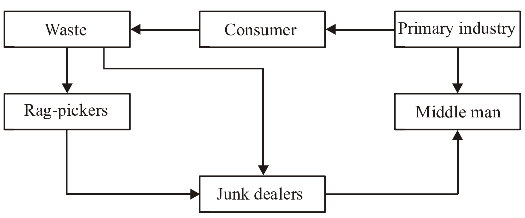


Fig. 10.3 *Waste recycling*

Reduce: Unnecessary waste generation can be reduced if one's own shopping bags are used and various items purchased from the market can be put in it, instead of taking several carry packs for several items.

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Disposal

Disposal is the final step in solid waste management system. Unfortunately, there is no organized disposal system in our country. There are several methods of solid waste disposal but only a few are followed in our country and that too without proper care. The three processes of solid waste disposal are:

1. Landfill: Disposing solid wastes in an 'open dump', *i.e.*, in an uncovered, usually a low lying area results in contamination of land and water, thereby spreading bad odours and diseases. The problems associated with 'open dump' are minimized to a large extent through 'Landfill'.

In case of sanitary landfill, an ideal site is chosen first. The site is generally selected at a distance of 1 to 2 km from the community. A site lying above the ground water table to prevent pollution of underground water is preferred. It is always beneficial to select a site containing soil having low permeability, to use it as an effective cover material. After selecting the proper site, a pit is dug in the ground. Mixed solid wastes with varying degree of composition are delivered to the site by trucks or trailer units. For effective landfilling, the wastes are hand sorted, pulverized or compacted by high pressure and baling for volume reduction is done. The loose material is placed in the lower part of the pit. It is then spread homogenously and compacted by machines such as bulldozers, in a layer of thickness of about 0.5 m. This layer structure is usually called a cell. After several operations when the cell depth is about 2 m, it is covered with 20 to 30 cm of earth. If the wastes contain large irregular shaped materials, it is necessary to increase the thickness of the cover. After several operations of cell-cover layering, the final cell is covered with fresh earth of about 1 m in height and again compacted.

The covering of waste (cell) each time with fresh earth prevents the waste from decaying. The waste is also prevented from being blown off by fast winds. The covering of fresh earth prevents the breeding of flies and mosquitoes.

Landfilling with wastes that are not hand sorted, may not be economical for a site with limited capacity. The reduction of waste volume is economical, as well as it enhances the life of the landfill.

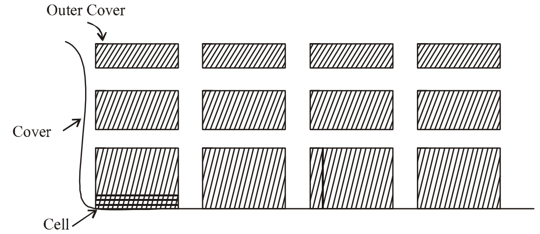


Fig 10.4 *Sanitary landfilling*

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Problems in Landfill: There always remains a problem with older landfills as far as ground water pollution is concerned. Pollutants seeping out from the bottom of a sanitary landfill generally percolate down to the ground water aquifer, no matter how thick the under lying soil layer be. Some care regarding this matter is taken and in many landfills, particularly in foreign countries, there are suitable bottom liners and leachate-collection system along with monitoring system to detect underground water pollution.

The landfill operation (particularly new landfill) is essentially a biological method of waste treatment. The organic material in the buried solid waste decomposes due to the action of microorganisms. The whole process of waste treatment takes place in five phases.

***Phase 1*: The waste decomposes aerobically, until the oxygen that was present in the freshly-placed fill is used up by the aerobic microorganisms.

***Phase 2*: The anaerobic conditions prevail and H_2 and CO_2 are evolved.

***Phase 3*: Methanogenic population of bacteria takes place and is the beginning of methanogenic activity. The bacteria decompose the matter to methane and CO2. Methane is highly poisonous and highly explosive when mixed with air in concentrations from 5 to 15 per cent.

***Phase 4*: The methanogenic activity becomes stabilized.

***Phase 5*: The methanogenic activity decreases, representing depletion of organic matter and finally, the system returns to aerobic conditions again.

The hazardous potential of methane should thus, be given due consideration. The carbon dioxide so produced reacts with water to form carbonic acid. The acidic environment thus, produced helps in dissolution of minerals and salts of Ca, Mg, Fe, Pb, Cd, Hg, Zn and various elements present in the wastes. These dissolved salts if percolate to ground water, they increase hardness and heavy metal toxicity of water.

The rate of decomposition in sanitary landfills depends on several factors. The weather condition, however, is not in our hand. The other factors however, can be controlled by introduction of proper technology. The aerobic decomposition rate will decrease if the wastes are compressed too tightly, so the wastes should be compacted in such a manner so as to have adequate amount of oxygen available. Also, the generation of methane and carbon dioxide should not get reduced. Again, there should be proper ventilation, a venting system to collect and vent the blocked gas to the outer surface in a controlled manner, in order to prevent explosion. The large amount of methane that is produced in the landfill can be tapped and used as a fuel.

Advantages of Landfill

- Flies, mosquitoes, many other insects, rats and other rodents cannot breed in the sanitary landfill and thus, infectious diseases are minimized.

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- Air pollution is prevented to a large extent as open burning is not employed and fire hazards are minimized.

(2) Incineration: The process of burning municipal solid waste in a properly designed furnace under suitable temperature (850° to 1100°C) and operating conditions is known as incineration. The modern municipal incinerator is of continuously burning type. The old technology of using refractory lining is replaced by water fall construction in the combustion chamber. In this system, the water is circulated through, steel made vertical boiler tubes. The circulated water absorbs the heat of combustion of waste and is successively used for space heating, power generation and can also be re-utilised for steam generation and heating the waste.

There are however, various other types of incinerators, namely (1) rotary kiln (2) open pit incinerators (3) controlled-air incinerators.

Incineration may reduce the volume of (MSW) by 90 per cent and weight by 75 per cent. In incineration, the process involved is oxidation. At the end of incineration, there remains bottom ash as well as solid residue and during the process there is a disposal of fly ash (ash floats out with hot air) into the atmosphere. Fly ash consists of finely divided particulate matter, mineral dust and soot. Both, the fly ash and bottom ash have high concentrations of toxins like dioxins, as well as heavy metals. The other types of gases exposed to air are sulphur dioxide, oxides of nitrogen, hydrochloric acid gas and many other organic acids. Disposal of ash is again a great problem. If buried, there remains the possibility of leaching, causing health hazard.

To reduce the problems associated with incinerations, first of all substances like glass and other non-combustible batteries, plastics, etc., containing heavy metals which can be recycled, should be removed. Equipment such as controlled-air-incinerator can be used, scrubbers (a device used to neutralize acid gases by spraying liquid) to prevent gases to enter atmosphere, filters to absorb tiny fly ash particles and lastly, extensive air-pollution control equipment should be used. Skilled labourers are required for proper maintenance.

The advantages associated with incineration thus are, utilization of energy generated through oxidation reaction and reduction of volume. But due to production of toxic materials, incineration is kept as the last resort and is used mainly to treat infectious waste such as biomedical waste.

(3) Composting: One effective way of disposing waste materials is composting. It is to be noted that all types of waste materials like plastic, glass wastes, building materials, etc., cannot be used for composting. The (MSW) thus, generated must be hand sorted, the other methods subsequently used can be gravity separation, electric and magnetic separation, as well as chemical or thermal separation, when required.

The municipal solid waste, such as cow dung, vegetable leaves, contains about 35–40 per cent of organic matter. For composting, a pit is dug in a large wasteland. All the required wastes are put into the pit and covered. The compositing waste is an aerobic biodegradation process. The microorganisms such as fungi and bacteria convert the degradable organic waste into humus like substance.

At the initial stage, mesophillic bacteria oxidize the organic substances in the waste to liberate CO_2 and heat. The temperature rises to about 45°C and at this point the bacteria take over and continue decomposition. During this process, the temperature attains about 60°C, high pressure is created and sufficient oxygen penetrates homogenously to support aerobic life. After about three weeks compost gets stabilized. The typical compost is dark brown in color with an earthy smell.

The compost is high in carbon and nitrogen. When the composting is done in a biogas unit (limited supply of oxygen), methane (biogas) is generated in a controlled way and is used for energy production as such and the residue is used as manure.

Another technology of compositing is vermicomposting. In this method, worms and insects are added to the compost. The idea has been obtained through long experience with nature. In nature it is seen that the wastes are degraded in a beautiful way through insects and worms. The leaves, dead animals, twigs are broken down by worms and insects and finally by bacteria and fungi to form compost.

Advantages of Composting

- Foul smell is eliminated.
- Flies and insects cannot breed.
- Gases like H_2S, CH_4 are reduced.
- Maximum nutrient (N, P, K) is obtained in a usable form.
- Harmful pathogens are killed.
- Excessive use of chemical fertilizer is reduced.
- Nutrient retention is enhanced.

Thus, through composting, pollution is abated, manure is generated, and biogas is produced.

Check Your Progress

5. Define soil erosion.
6. What is R principle of waste management?
7. What are the advantages associated with incineration?

10.4 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

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1. Noise pollution can be defined as the unwanted sound dumped into the environment, unwanted due to the adverse effects it may have in relation to physical and mental health, displeasing effect, human communication, etc.
2. The sound more than 130 dB causes noise pollution.
3. The science of human hearing sound is called human acoustics.
4. Two important parameters of sound are sound pressure and intensity.
5. Soil erosion means wearing away of soil. It is defined as the movement of soil components, especially surface-litter and top soil from one place to another.
6. Generation of waste can be minimized and the generated waste can be converted to wealth with the help of four *R* principle of waste management. The four *R* principle stands for: (1) Refuse (2) Reuse (3) Recycle (4) Reduce.
7. The advantages associated with incineration thus are, utilization of energy generated through oxidation reaction and reduction of volume.

10.5 SUMMARY

- Noise is an unwanted, irregular, unpleasant and annoying sound, *i.e.*, sound with no musical quality. The definition however, is subjective because one man's sound may be another man's noise. Noise can thus be defined as 'wrong sound, in the wrong place, at the wrong time'.
- The poor elasticity of air causes the disturbance (the pressure variation) which causes sound to travel at a slow speed of around 330 ms–1. The extent of disturbance depends upon the rate of vibration of the vibrating object, the dissipative losses in the air molecules, the pressure of wind, temperature gradient and turbulence on the boundary surfaces.
- The sound more than 130 dB causes noise pollution.
- The science of human hearing sound is called human acoustics. Human acoustics specifically indicates the different processes that are involved in the perception of some sound by our ears.
- Two important parameters of sound are sound pressure and intensity.
- Noise level in decibel is measured with an instrument called sound level meter. It consists of three internationally accepted weighting networks, namely *A*, *B* and *C*.
- Noise may originate from natural sources as well as through anthropogenic activities. The natural sources are cyclone, thunder, roaring of sea, volcanic

eruption, etc. The anthropogenic sources are heavy machineries used in the industry, mechanized automobiles, trains, aero planes, washing machine, television, etc.

- Occupational noise is mainly produced by industrial machines and processes like blasting operations, shipbuilding, factories and mills producing different kinds of products. Occupational noises are also due to machines used for domestic purposes such as television, washing machines, vacuum cleaners, etc.
- Loud sounds can cause an increased secretion of various hormones of the pituitary gland, leading to increased blood sugar level, reducing immune system capability, effecting liver, heart, brain and kidney.
- There are some recommended threshold limit values of impact or impulsive noise levels. For time intervals, greater than one second is considered as impulsive or impact noise and less than one second as continuous. Exposure to more than 140 dBA peak sound pressure level is never permitted.
- The noise generated in the environment can never be eliminated completely, however, it can be controlled.
- In the industrial establishment, control at source can be done by proper design, proper operation and regular maintenance of the machines. The industry should be located at open spaces far off from the residential areas.
- Sound insulators reduce sound transmission through barriers. Sound insulating materials could be glass, steel, ceramic materials, concrete, etc.
- It should be mentioned that plants and trees have a greater capacity for reduction of noise. Plants are efficient absorbers of noise, especially noise of high frequency. Thus, plantations along highways, streets and industrial areas should be done.
- Soil erosion means wearing away of soil. It is defined as the movement of soil components, especially surface-litter and top soil from one place to another. It results in the loss of fertility.
- Various anthropogenic activities like hydroelectric projects, large dams, reservoirs, construction of roads and railway lines, construction of buildings and mining are responsible for clearing of large forested areas.
- The open burning or fire generation due to organic decomposition may lead fire to continue for a longer period and may cause high degree of water and air pollution due to the release of leachable toxic materials into water, exerting oxygen demand and other pathogen along with noxius gases, creating health hazard problem.
- It is only through scientific, disciplined and effective solid waste management, that the four problems can be minimized or abated to the maximum possible extent. The present day management follows: (1) collection (2) storage (3) transportation (4) recycling (5) treatment (6) disposal.

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- Generation of waste can be minimized and the generated waste can be converted to wealth with the help of four *R* principle of waste management. The four *R* principle stands for: (1) Refuse (2) Reuse (3) Recycle (4) Reduce.
- During the recycling process, the wastes are collected, materials are processed and newer products are generated. Before recycling, the wastes are segregated to separate out biodegradable wastes from non-biodegradable waste. The biodegradable waste, such as household garbage, leaves, flowers, fruits from gardens can be used in compost pit and used as fertilizers.
- Disposal is the final step in solid waste management system.
- Disposing solid wastes in an 'open dump', *i.e.*, in an uncovered, usually a low lying area results in contamination of land and water, thereby spreading bad odours and diseases. The problems associated with 'open dump' are minimized to a large extent through 'Landfill'.
- For effective landfilling, the wastes are hand sorted, pulverized or compacted by high pressure and baling for volume reduction is done. The loose material is placed in the lower part of the pit. It is then spread homogenously and compacted by machines such as bulldozers, in a layer of thickness of about 0.5 m.
- The process of burning municipal solid waste in a properly designed furnace under suitable temperature (850° to 1100°C) and operating conditions is known as incineration.
- One effective way of disposing waste materials is composting. It is to be noted that all types of waste materials like plastic, glass wastes, building materials, etc., cannot be used for composting. The (MSW) thus, generated must be hand sorted, the other methods subsequently used can be gravity separation, electric and magnetic separation, as well as chemical or thermal separation, when required.

10.6 KEY WORDS

- **Noise pollution:** It is the regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms.
- **Oscillation:** It is the regular variation in magnitude or position around a central point.
- **Soil erosion:** It is the displacement of the upper layer of soil; it is a form of soil degradation.
- **Landfill:** It is a place to dispose of refuse and other waste material by burying it and covering it over with soil, especially as a method of filling in or extending usable land.
- **Composting:** It is an aerobic method (meaning that it requires the presence of air) of decomposing organic solid wastes.

10.7 SELF ASSESSMENT QUESTIONS AND EXERCISES

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Short-Answer Questions

1. What are the applications of sound waves?
2. State the effective strategies for abating noise levels.
3. List the conservation practices to prevent soil erosion and conserve the soil.
4. What are the advantages of composting?

Long-Answer Questions

1. Classify the anthropogenic noise. Explain its types with examples.
2. Describe the effects of noise pollution.
3. Explain the solid waste management strategy.
4. Illustrate the landfill process of solid waste management system.

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UNIT 11 ENVIRONMENTAL THREATS-III

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Structure

11.0 INTRODUCTION

Over the last few decades, the condition of the environment has deteriorated at an unprecedented rate. Some of the most pressing environmental issues today are deforestation, generation of hazardous waste and industrial pollution. All of these have an adverse effect on not just the environment but also on the health and lives of humans and other living organisms. In order to tackle these issues, a sincere effort towards their containment as well as a proper plan to manage these is required on the part of the authorities concerned and also on the level of every individual. In this unit, a discussion of the causes and management of the aforementioned problems has been undertaken.

11.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss the causes and consequences of deforestation
- Analyse the disposal and management of hazardous waste.
- Describe the causes and effects of industrial pollution

11.2 DEFORESTATION

Forest resource is the dense growth of trees, together with other plants, covering a large area of land. Forests are one of the most natural resources found on earth. Covering earth like a green blanket, these forests not only produce innumerable

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material goods, but also provide several environmental services which are essential for life.

About one-third of the world's land area is forested, which includes closed as well as open forests. Former USSR accounts for about one-fifth of the world's forests, Brazil for about one-seventh and Canada and USA each has 6–7 per cent. However, it is a matter of concern that almost everywhere the cover of the natural forests has declined over the years. The greatest loss occurred in tropical Asia, where one-third of the forest resources have been destroyed.

Uses of Forests

Commercial uses: Forests provide us a large number of commercial goods which include timber, firewood, pulpwood, food items, gum, resins, non-edible oils, rubber, fibres, lac, bamboo canes, fodder, medicine, drugs and many more items, the total of which is estimated to cost more than $300 billion per year.

Half of the timber that is cut each year is used as fuel for heating and cooking. One-third of the wood harvest is used for building materials as lumber, plywood and hardwood, particle board and chipboard. One sixth of the wood harvest is converted into pulp and used for paper industry. Many forest lands are used for mining, agriculture, grazing, and recreation and for development of dams.

Ecological uses: While a typical tree produces commercial goods worth about $590, it provides environmental services worth nearly $196 to $250.

The ecological services provided by forests may be summed up as follows:

1. ***Production of oxygen*****:** Trees produce oxygen by photosynthesis which is so vital for life on this earth. They are rightly called earth's lungs.
2. ***Reducing global warming*****:** The main greenhouse gas, carbon dioxide (CO_2), is absorbed by the forests as a raw material for photosynthesis. Thus, forest canopy acts as a sink for CO_2, thereby reducing the problem of global warming caused by greenhouse gases such as CO_2.
3. ***Wild life habitat*****:** Forests are the homes of millions of wild animals and plants. About 7 million species are found in the tropical forests alone.
4. ***Regulation of hydrological cycle*****:** Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the run-off and slowly releasing the water for recharging of the springs. About 50-80 per cent of the moisture in the air above tropical forests comes from their transpiration, which helps in bringing rains.
5. ***Soil conservation*****:** Forests bind the soil particles tightly in their roots and prevent soil erosion. They also act as windbreaks.
6. ***Pollution moderators*****:** Forests can absorb many toxic gases and can help in keeping the air pure and clean. They have also been reported to absorb noise and thus, help in preventing air and noise pollution.

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Overexploitation of Forests

Since time immemorial, humans have depended heavily on forests for food, medicine, shelter, wood and fuel. With growing civilizations, the demands for raw materials like timber, pulp, minerals and fuel wood shooted up resulting in large-scale logging, mining, road-building and clearing of forests. Our forests contribute substantially to the national economy. The international timber trade alone is worth over US $40 billion per year. Excessive use of fuel wood and charcoal, expansion of urban, agricultural and industrial areas and overgrazing have together led to overexploitation of our forests leading to their rapid degradation.

Deforestation

According to the World Bank, the total forest area of the world in 2000 was estimated to be 40737562 Sq km, which was reduced to 40204180 in 2010. Deforestation rate is relatively less in temperate countries, but it is very alarming in tropical countries, where it is as high as 40-50 per cent; at the present rate, it is estimated that in the next sixty years we would lose more than 90 per cent of our tropical forests.

According to the India State of Forest Report (ISFR), 2015, the total forest and tree cover is 79.42 million hectare, which is 24.16 per cent of the total geographical area. India's forest and tree cover has increased by 5, 081 sq km. While the total forest cover of the country has increased by 3, 775 sq km, the tree cover has gone up by 1, 306 sq km. The report states that the majority of the increase in forest cover has been observed in open forest category mainly outside forest areas, followed by Very Dense Forest. While Open Forest area has increased by 4, 744 sq km, which is 9.14 per cent of the geographical area, the area under Very Dense Forest has increased by 2, 404 sq kms, which is 2.61 per cent of the geographical area. About 40 per cent forest cover is in 9 big patches of 10, 000 sq km and more. The increase in total forest cover also includes an increase in the mangrove cover.

However, we are still far behind the target of achieving 33 per cent forest area.

Major causes of deforestation

1. ***Shifting cultivation:*** There are an estimated 300 million people living as shifting cultivators who practice slash and burn agriculture. In India, we have this practice in the north-east and to some extent in Andhra Pradesh, Bihar and MP, which contribute to nearly half of the forest clearing annually.
2. ***Fuel requirements:*** Increasing demands for fuel wood by the growing population in India alone has shooted up to 300-500 million tonnes in 2001 as compared to just 65 million tonnes during independence, thereby increasing the pressure on forests.

3. ***Raw materials for industrial use:*** Wood for making boxes, furniture, railway-sleepers, plywood, match boxes, pulp for paper industry, etc., have exerted tremendous pressure on forests. Plywood is in great demand for packing tea, while fir tree wood is exploited greatly for packing apples.
4. ***Development projects:*** Massive destruction of forests occurs for various development projects like hydroelectric projects, big dams, road construction and mining.
5. ***Growing food needs:*** In developing countries, this is the main reason for deforestation. To meet the demands of a rapidly growing population, agricultural lands and settlements are created permanently by clearing forests.
6. ***Overgrazing:*** The poor in the tropics mainly rely on wood as a source of fuel leading to loss of tree cover and the cleared lands are turned into grazing lands. Overgrazing by cattle leads to further degradation of these lands.

Major consequences of deforestation

Deforestation has far reaching consequences, which may be detailed as follows:

1. It threatens the existence of many wild life species due to destruction of their natural habitat.
2. Biodiversity is lost and along with that genetic diversity is eroded.
3. Hydrological cycle gets affected, thereby influencing rainfall.
4. Problems of soil erosion and loss of soil fertility increase.
5. In hilly areas, it often leads to landslides.
6. The effects of global warming may aggravate due to loss of oxygen generation and increase in the level of carbon dioxide in the air.

Major Activities in Forests

Timber extraction: Logging for valuable timber such as Teak and Mahogany not only involves a few large trees per hectare, but about a dozen more trees since they are strongly interlocked with each other by vines and construction of roads in forest causes further damage to the forests.

Mining: Mining operations for extracting minerals and fossil fuels like coal often involve vast forest areas. Mining from shallow deposits is done by surface mining, while that from deep deposits is done by sub-surface mining. More than 80,000 ha of land in this country is presently under the stress of mining activities. Mining and its associated activities require removal of vegetation along with the underlying soil mantle and overlying rock masses. This results in defacing the topography and destruction of the landscape in the area.

Large-scale deforestation has been reported in Mussoorie and Dehradun valley due to indiscriminate mining of various minerals over a length of about forty kilometres. The forested area has declined at an average rate of 33 per cent and

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the increase in non-forest area due to mining activities has resulted in relatively unstable zones, leading to landslides.

Indiscriminate mining in forests of Goa since 1961 has destroyed more than 50,000 ha of forest land. Coal mining in Jharia, Raniganj and Singrauli areas have caused extensive deforestation in Jharkhand. Mining of magnesite and soap-stones have destroyed 14 ha of forest in hill slopes of Khirakot, Kosi valley, Almora. Mining of radioactive minerals in Kerala, Tamilnadu and Karnataka are posing similar threats of deforestation. The rich forests of Western Ghats are also facing the same threat due to mining projects for excavation of copper, chromite, bauxite and magnetite.

Mining Engineering: Mining engineering is a field that involves many of the other engineering disciplines as applied to extracting and processing minerals from a naturally occurring environment.

The need for mineral extraction and production is an essential activity of any technically proficient society. As minerals are produced from within a naturally occurring environment, disturbance of the environment as a result of mineral production is a given. Modern mining engineers must therefore be concerned not only with the production and processing of mineral commodities, but also with the mitigation of damage or changes to an environment as a result of that production and processing.

The two primary types of mines are underground mines and open-pit mines. Minerals that exist relatively deep underground (eg. some coal seams, gold and some metalliferous ores) are generally recovered using underground mining methods. Minerals like iron ore, shallow coal seams and bauxite are usually recovered from the surface by open pit mining.

Dams and their Effects on Forests and People

Big dams and rivers valley projects have multi-purpose uses and Pandit Jawaharlal Nehru used to refer to these dams and valley projects as ‘Temples of modern India’. However, these dams are also responsible for the destruction of vast areas of forests. India has more than 1550 large dams, the maximum being in the state of Maharashtra (more than 600), followed by Gujarat (more than 250) and Madhya Pradesh (130). The highest one is Tehri dam, on river Bhagirathi in Uttarakhand and the largest in terms of capacity is Bhakra dam on river Satluj in Himachal Pradesh.

Big dams have been in sharp focus of various environmental groups all over the world, because of several ecological problems including deforestation and socio-economic problems related to tribal or native people associated with them.

The Silent Valley Hydro-Electric Project was one of the first such projects situated in the tropical rain forest area of Western Ghats, which attracted much concern of the people.

The crusade against the ecological damage and deforestation caused due to Tehri dam was led by Shri Sunderlal Bahaguna, the leader of Chipko Movement. The cause of Sardar Sarovar Dam related issues taken up by the environmental activitist Medha Patkar, joined by Arundhati Roy and Baba Amte.

For building big dams, large-scale devastation of forests takes place which breaks the natural ecological balance of the region. Floods, droughts and landslides become more prevalent in such areas.

Forests are the repositories of invaluable gifts of nature in the form of biodiversity and by destroying them (particularly, the tropical rain forests), we are going to lose these species even before knowing them. These species could have marvelous economic or medicinal value and deforestation results in loss of this storehouse of species which have evolved over millions of years.

Check Your Progress

1. What has led to rapid degradation of forests?
2. List two consequences of deforestation.
3. How are minerals that exist relatively deep underground recovered?

11.3 HAZARDOUS WASTE

Hazardous waste is commonly produced in industries and hospitals. Hazardous waste of industries contains chemicals and toxic substances that can be very harmful to humans and surroundings which are exposed to them. Hazardous waste of hospitals contains pathogens, chemicals and substances which could be harmful to humans and the environment if not disposed of properly. Pathogens in the waste pose the grave risk of spreading diseases and illnesses.

The equipment and storage space, used to handle both the industrial and hospital waste, can also carry toxins. Even small traces of waste, left on the equipment or in storages, can cause dangerous side-effects to a large number of people. Hazardous waste has been carefully classified into eighteen categories. Identification of the source and category of hazardous waste helps trace the cause of its generation and how it can be reduced at the source itself. It also helps in deciding an appropriate method or treatment for its disposal.

Category and source identification

Table 11.1 *Hazardous waste classification*

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Waste Category	Type of Waste
Category No. 1	Cyanide waste
Category No. 2	Metal finishing waste
Category No. 3	Waste containing water soluble chemical compounds of zinc, copper, lead, chromium and antimony
Category No. 4	Mercury, arsenic, thallium, cadmium bearing waste
Category No. 5	Non-halogenated hydrocarbons including solvent
Category No. 6	Hydrogenated hydrocarbons including solvent
Category No. 7	Wastes from paints, pigments, glue, varnish and printing ink
Category No. 8	Wastes from dye and dye intermediate containing inorganic chemical compound
Category No. 9	Wastes from dyes and dye intermediates containing organic chemical compounds
Category No. 10	Waste oil and oil emulsions
Category No. 11	Tarry wastes from refining and tar residues from distillation or prolytic treatment
Category No. 12	Sludges arising from treatment of waste waters containing heavy metals, toxic organics, oil emulsions and spend chemical and incineration ash
Category No. 13	Phenols
Category No. 14	Asbestos
Category No. 15	Wastes from manufacturing of pesticides and herbicides and residues from pesticides and herbicide formulation units
Category No. 16	Acid/Alkaline/Slurry
Category No. 17	Off-specification and discarded products
Category No. 18	Discarded containers and container linears of hazardous waste

Source: *envis.kuenvbiotech.org/Hazardous-waste-managements.doc*

As we can see in Table 11.1, there are eighteen categories into which hazardous waste has been classified. This categorization helps in deciding the nature of the waste and how it should be treated.

Knowing about the components that are hazardous in a waste is only one aspect of hazardous waste management. Identification of hazardous waste source is also very crucial to its proper management. Understanding how the hazardous waste has been produced allows one to estimate the damage it can cause and choose the best mode for its treatment. Also, tracing back the source of hazardous waste helps organize the required collection and transportation facilities.

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Characterization

Hazardous waste has four main characteristics which are responsible for causing ill-effects to humans or surroundings. Any waste which has one or more of these characteristics is categorized as hazardous waste. These characteristics are as follows:

- **Flammability:** This decides how easily hazardous waste can catch fire and how difficult it could be to put the fire out. Waste flammability helps estimate the kind of damage the waste can cause and know about the substances which can be used to treat it. This also gives the idea to keep it well stored and devise safety techniques to overcome any potential danger.
- **Reactivity:** This means the waste might chemically react with skin, air or even water to cause devastating results. Or, it could even mean that the waste can trigger nuclear reactions that release high amounts of energy which cannot be curbed without proper equipment.
- **Corrosiveness:** This indicates the waste's ability to damage or destroy anything it comes in contact with. The damage done is almost always irreversible.
- **Toxicity:** This is the degree to which the waste can cause damage to non-living and living things. Toxicity of a substance decides the way cells, tissues, organs or other substances would deteriorate. It has the ability to rearrange the substructure of organisms.

Quantification

Quantification of hazardous waste is the estimation of waste production in an area. It helps researchers assess the amount of waste generation from a particular product or process. Accordingly, benchmarks are set to bring down the waste quantity and new methods are devised to reduce waste generation. Quantification also helps assess the efficiency of the hazardous waste management techniques being used.

Hazardous Waste Handling and Disposal

A number of precautions need to be considered while handling and disposing of hazardous waste. One must ensure that the people authorized to handle the waste are fully qualified for the job and are well-versed with all the required safety procedures. The waste-handlers must also know about the waste source and

inform transporters in the vicinity about the same to ensure that the hazardous waste does not reach those dumping sites where it cannot be managed. They should also regularly check the containers used for waste storage. The containers should be guarded against the corrosive or highly reactive wastes which can damage the containers and escape into the environment. Hazardous wastes also need to be segregated during storage to ensure minimum chances of reaction with the containers or other things and also for determining the appropriate waste treatment methods.

Transport

Hazardous waste needs to be transported from its production site to the site where it is treated and disposed of. Some production sites can partially treat the waste before its transportation to reduce the risks associated with its exposure. However, it cannot be treated completely unless the site of its generation is equipped with appropriate treatment technology. Small waste treatment includes changing the pH level to reduce its acidity or performing small-scale chemical reactions to prevent occurrence of dangerous reactions later on. The biggest risk during waste transportation is any kind of waste spill or leak on the way which could endanger a number of lives. Therefore, to reduce transportation risks or avoid long-distance transportation, industries are mostly located at one particular site and the waste disposal sites are also situated nearby.

Another thing that needs to be considered when transporting hazardous waste is that it should not be mixed with non-hazardous waste. Even if the two do not have reactionary properties, non-hazardous waste can become infectious or acquire harmful traits. But the waste-handlers may not know of this change in the properties of non-hazardous waste and would unsuspectingly subject themselves to grave risks.

Storage

Hazardous waste storage is a time-bound process. After its generation, the waste is stored at the source site for certain duration before its transportation to a disposal site. Even after transportation, the waste may be stored at the disposal site itself for some time before its treatment and final disposal. Waste storage must be carried out with required precautions. The storage containers must be resistant to any reaction with hazardous waste because reaction with the waste may cause waste leakage, leading to devastating results for the humans and surroundings. Besides, the waste containers after reacting with the waste may suffer permanent damage and become useless.

People involved in handling the storage of the hazardous waste need to take extra precautions to ensure that they do not come in direct contact with the same. During both storage and transportation, the containers should be appropriately coloured or labelled with a statutory warning. The labels on the

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containers are of vital importance. These labels must correctly identify the waste in the containers and list its various properties such as corrosiveness, toxicity, reactive and infectious nature. These labels enable the waste-handlers to do their work without exposing themselves to unwanted risks.

Disposal of Small and Large Quantities

Disposal of both small and large quantities of waste is done on the basis of the hazardous waste mapping system. This system allows one to carry out the required procedures for all types of wastes to ensure proper treatment and disposal. Monthly output of hazardous waste amounting to 100 kilograms or more but less than 1,000 kilograms is termed as small-quantity waste. This waste can be stored on the site of its generation for up to 180 days before transportation for disposal. The waste storage on the site must not exceed 6,000 kilograms, and well-trained, educated employees should be deployed for efficient handling the waste storage. They should ensure that the waste does not produce the harmful effects on its surroundings. They are also responsible for any emergencies arising out of waste storage.

Monthly output of hazardous waste exceeding 1,000 kilograms is termed as large-quantity waste. These wastes cannot be stored on site longer than 90 days and must be sent for disposal within this time. The industry staff needs to regularly track the production, storage and transportation of waste in large quantities, and also be ready to carefully tackle any emergencies. The industries producing large quantities of waste need to submit the biennial hazardous waste report to the government.

Disposal of Dioxin, PCB and Toxins

Wastes containing dioxins, PCB and toxins, on coming in contact with other kinds of waste at the disposal site, can lead to harmful chemical reactions, corrosive damages, etc. Therefore, these wastes must be disposed of in strict accordance with the government-approved methods. These wastes can be disposed of in landfills, or can be treated with chemicals. These can also be subjected to incineration. However, all these methods need government approval before implementation. Without this approval, a site cannot be used for dioxin, PCB and toxins disposal. And, a site once designated for this purpose cannot be shared with other kinds of waste. Other techniques, used for disposing of dioxin/toxin-containing waste, include physical/chemical extraction techniques, biological reduction methods, melting furnace, pyrolysis, etc.

Hazardous waste disposal sites need government approval because hazardous waste cannot be disposed along with other wastes in general sites neither can it be disposed of in areas near to human habitations. Thus government employees must approve hazardous waste disposal sites before they become operative.

Disposal of Infectious Hazardous Waste

The best method for disposing infectious hazardous waste is incineration or any other thermal technique. Incineration is preferred the most because it effectively reduces the mass and volume of the waste. Another notable advantage is that this high-temperature process also kills any pathogens that can spread diseases and infections. However this method cannot be used all the time. There are also other methods for disposal of infectious hazardous waste but they are not always the best alternative. One such method is sterilization by autoclaves, which is also called autoclaving.

An autoclave is a device which rids hospital equipment of traces of hazardous waste by subjecting them to high pressure saturated steam. Liquid and semi-solid infectious waste can be disposed of in sewers which have been approved for such disposal. The sewer endings are directly linked to the disposal sites where the waste is collected for treatment. An essential precaution for handling infectious hazardous waste is that its disposal must be carried out within a week. Otherwise, the storage containers may become a breeding ground for pathogens which can pose grave risks to the people around.

Hazardous Waste Management in India

The Ministry of Environment and Forests (MoEF), Government of India issued a notification on 28 July 1989, which informed that the Hazardous Waste (Management & Handling) Rules (HWM Rules) will deal with wastes which are not covered under the Water and Air Acts. These wastes include hazardous waste (HW), mostly solids, semi-solid and other industrial wastes. The notification, designed under the provisions of the Environment (Protection) Act, 1986, was introduced to facilitate the management of waste handling, treatment, transport and disposal in an environmentally sound way by the authorities.

In 2000 and 2003, the notification was further amended. These amendments were presented as Schedule I and Schedule II. Schedule I identified hazardous wastes by means of waste streams and industrial processes, while Schedule II identified the concentrations of specified components of the hazardous waste. Further, Schedule VIII was formulated, which identified the categories of wastes that were prevented from being exported or imported. The procedure for the registration of the reprocessors/recyclers possessing environmentally feasible facilities for processing waste categories like non-ferrous metal, used lead acid batteries and used oil as contained in Schedule 4 and Schedule 5 respectively has also been laid down.

Hazardous waste management in India has been divided into the following seven steps to ensure adherence to all essential precautions and prerequisites of the process without any hindrance. These steps lay down the basic procedure that needs to be followed for safe disposal of hazardous waste.

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- **Identification of hazardous waste:** The first step is to identify hazardous waste, that is, whether a particular waste is hazardous or not. Identifying a waste as hazardous and locating its generation site brings it under close scrutiny of government authorities. Then they coordinate collection and transportation of the waste to the disposal sites nearest to its generation area to reduce any risks and accidents which could occur if it is sent for faraway disposal.
- **Data collection:** Questionnaires, field visits and surveys help estimate the hazardous waste being produced at different sites in an industrial area. Depending on the estimated amount of waste and the availability of storage facilities, the decision is taken to prioritize waste collection from the sites.
- **Waste categorization:** The waste needs to be correctly categorized into its respective category to decide suitable treatment for it. If the waste categorization is wrong, it will not get disposed in the right manner and then it can be harmful to the environment as well as the people in the area.
- **Quantification of hazardous waste:** Different kinds of hazardous waste being generated in an industry or a region are quantified to estimate the scale of the required waste treatment and have an idea of the potential risks. Quantification helps in estimating the wastes being produced in every process and how each process can be improvised to reduce waste production.
- **Identification of disposal sites:** Government officials visit prospective sites which can be used for waste disposal. The chosen site should be far away from the high-density population areas and it should have enough space to accommodate waste disposal equipment. It should also be equipped with good transport facility to allow easy waste collection at the site.
- **Conducting EIA:** The environmental impact analysis (EIA) helps one understand how the hazardous waste is going to be harmful to the environment. It helps in deciding why it is important go for systematic hazardous waste disposal. It also gives an idea of the adverse effects on the waste-handlers and how those can be prevented.
- **Implementing TSDF programme:** The TSDF (Transport Storage and/or Disposal Facility) Programme decides how the hazardous waste would be treated. It lists techniques which would be used for certain categories of hazardous waste and why these techniques would be appropriate for these wastes. This programme also decides on the labels, messages and pictures which need to be used to classify hazardous waste for all those dealing with it.

Present hazardous waste generation scenario

India generates about 4.4 million tonnes of hazardous waste on an annual basis. As per the estimates by the Organization for Economic Cooperation and Development (OECD), around five million tonnes of hazardous waste are being

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produced in India on an annual basis. These estimates are based on the eighteen categories of wastes that appeared in the HWM Rules published in 1989. Out of this, 38.3 per cent is recyclable, 4.3 per cent is incinerable and the remaining 57.4 per cent is disposable in secured landfills. Twelve States of the country (Gujarat, Maharashtra, Orissa, Tamil Nadu, Assam, Madhya Pradesh, Kerala, Uttar Pradesh, West Bengal, Andhra Pradesh, Karnataka and Rajasthan) account for 97 per cent of the total hazardous waste generation.

Maharashtra, Gujarat, Andhra Pradesh and Tamil Nadu are the top four waste generating states. On the contrary, states like Jammu & Kashmir, Himachal Pradesh and all the North Eastern States excepting Assam produce less than 20,000 MT annually. The approach to waste management should be necessarily state-specific because of the wide variations in quantity and nature of waste produced among the states and union territories (UTs). It is also required because of the big variations in climatic as well as hydro-geological conditions in various regions of India.

As a result of the amendments made in 2000 and subsequently in 2003, the State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) have undertaken the process of re-inventorizing hazardous waste generated. These steps have brought to light the serious short-comings in the earlier inventorization.

The Basel convention on hazardous wastes

India is a signatory to the Basel Convention on transboundary movement of hazardous wastes. The Basel Convention aims to control and reduce the transboundary movements of hazardous and other wastes. The Convention has the objectives of prevention and minimization of hazardous waste generation, environmentally appropriate management of these wastes, and the promotion and use of cleaner technologies.

As a member of the Convention, India is under obligation to regulate and minimize the import of hazardous waste or other wastes for disposal or re-cycling. The country is also obliged to prohibit the export of waste to the parties that have prohibited the import of these wastes. As a member, India is also needed to minimize the generation of hazardous waste in its territory taking into account the social, technological and economic aspects. Moreover, hazardous waste produced in the country has to be managed in an environment-friendly manner. As a party, India can prevent the import of hazardous waste or other waste if it believes that the concerned waste cannot be managed in an environmentally feasible way.

Check Your Progress

4. What does hazardous waste of hospitals contain?
5. What does small waste treatment include?
6. What is the best method for disposing infectious hazardous waste?
7. What are the objectives of the Basel Convention on hazardous wastes?

11.4 INDUSTRIAL POLLUTION

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Any business effects the environment and causes air, water and noise pollution. These are harmful for us in terms of affecting our ecological balance and prevent sustainable development for the preservation of our resources. Industrial and business activities cause a lot of damage to our environment, all of which is discussed further in this unit.

Industrial Pollution

Industrial pollution refers to the pollution of our environment by industrial wastes, which are harmful in the long-run. Industrial pollution is of various kinds:

a) Air pollution
b) Noise pollution
c) Water pollution
d) Thermal pollution
e) Marine pollution
f) Soil pollution
g) Nuclear pollution

Role of Competition and Consumerism

Due to rapid industrialization, the comparative gap between the rich and the poor is widening. Those with jobs and those without have equally experienced the reality of the rat race of daily life. They are willing to spend it for their comforts and those who lack money are resorting to anti-social activities resulting in increase in crimes, especially financial crimes like robberies, embezzlement and misappropriations. It is the impact of the continuous increase in salaries and wages every year, that the habits of spending have undergone a change. In such a society, those who have jobs and a reasonable salary or wage, are now not worried about the money in their pockets. Such people are willing to buy articles beyond their buying capacity. There is an increasing tendency of resorting to avail loans from financial institutions, banks. The saving habits of the previous generations are getting converted into spending habits.

Issues in Environment Management for Business

What exactly are environmental issues and how do these specifically affect people? For business, environmental issues include:

- deterioration of land quality,
- accumulation of waste,
- water pollution,
- air pollution, etc.

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There are ways to overcome these environmental issues and they are discussed as follows:

- **Global warming:** Increased emission of carbon dioxide and other hot gases into the environment is the perceived culprit in the climate change and consequent disasters. Climate change can not only result in such direct disasters as hurricanes and long winters, but also affect agriculture and food availability.
- **Loss of biodiversity:** It is biodiversity in the form of numerous organisms that makes life on this earth sustainable. Organisms make the soil fit for cultivation, destroy pests and maintain climate, among other things. Killing these organisms by destroying forests and other such practices can make life on the planet very different and difficult.
- **Water and air pollution:** Persistent organic pollutants and toxic materials, such as pesticides and industrial wastes can accumulate in living tissues disrupting endocrine systems, suppressing immunity functions and causing reproductive and developmental changes. Also, the pollutants can travel long distances crossing international borders through air, water and migratory species.
- **Land degradation:** Unsustainable felling of trees and exploitation of water can lead to desertification of presently habitable regions while destruction of mangroves and other practices can lead to erosion of coastal areas.
- **Chemical waste:** In a chemical industry, the environmental issues are chemical spills. A spill can injure employees or make them sick. It can lead to fires and other property damage. It can become a source of bad press and jeopardize your relationship with the community. A chemical spill can easily find a waterway or groundwater, which can be disastrous for the environment in the long run. In order to avoid such accidents, it is necessary to be prepared for spills, and train the employees.

It is thus obvious that life on earth will be a very different proposal in the future if current human practices continue unchecked. The situation will be aggravated when the non-renewable energy sources, such as oil, get exhausted without any sustainable energy sources replacing them.

Environment Protection Initiatives

Governments and leaders have begun to recognize how serious the situation is and many initiatives are being taken. However, political compulsions and inadequate resources and projects are hampering sufficiently forceful action.

The initiatives include the following:

- Creating awareness among the public is a major focus area. Results have also begun to appear with public resistance against many practices that lead to environment damage, such as cutting down trees and the preference for pesticide-free food.

- Government regulations have made businesses take specific actions and avoid others to protect the environment and public health. Trees cut from forests need to be compensated by replanting, angling is restricted and pollution control is a major focus area.
- Research efforts are being intensified to tap renewable energy sources, such as solar, wind power and biomass energy. Biomass energy involves using waste materials like wood chips, straw, sewage sludge and bio-waste to generate energy. Unlike bio-fuels, biomass does not compete for resources that can be used for food.
- Reputed businesses are developing alternatives that use less energy. For example, Siemens claims on their website that their combined-cycle power plants use hot waste-gases (that were formerly released into the environment) to generate steam for downstream turbines, reducing fuel needed to generate power by as much as 60 per cent.
- There are several standards and reforms to keep a check on the businesses. ISO 14001, published by International Standards Organization, is a standard that seeks to focus the attention of industrial units on environmental issues. Accounting reforms seek to account for environmental costs of business operations, in addition to financial costs.

Businesses that act with environmental responsibility are even beginning to see improvements in their bottom lines. Environmental management is more about managing the interactions of human societies with the environment rather than managing the environment.

Human activities have led to considerable degradation of the environment and the situation is threatening to become dangerous to life on earth. Persistent toxic substances that do not degrade for months to years are already leading to poorer quality of life for people, while climate change is leading to many disasters.

There is a growing concern in developed nations about the ever-increasing environmental degradation due to industrialization. Even though the level of environmental pollution is much less in developing nations, it a cause for alarm there, too. There is total agreement throughout the world that any further environmental degradation should be effectively and completely checked. Heavy pollution in some of the larger cities in the world, e.g., London, New York, Los Angeles, Mumbai, Istambul, Ankara, etc., has already taken a serious turn and the necessity to control ever growing pollution is obvious. There are main two approaches for environmental management:

1. Management based on standards
2. Management based on best practicable means.

The first approach requires statutory provision for standards for each pollutant for air, water, noise and soil pollution. In this approach, each polluter could choose a suitable technique for pollution control, based on their evaluation

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for technical feasibility and economic viability. A regular monitoring of each relevant pollutant and its comparison with prescribed limit will indicate the amount of pollution to be removed by pollution control. However, should there be any deviation from the prescribed limits, penal action could be taken against the polluter. There should be standards indicating the permissible units for liquid effluents. It should be noted that the permissible limits are higher for disposal on land because, due to percolation, there will be significant reduction in their values before their joining the water systems and, in case where effluent is discharged directly into river system, the effect will be direct and naturally the permissible limits are lower.

Regarding air pollution, the standards for ambient air quality should also be given indicates that the permissible limits are highest for industrial areas but lowest in the case of sensitive areas including Agra-Mathura region, due to location of Taj Mahal, and the entire hill area including Kumaon and Garhwal region of the state.

The standards for noise pollution should also be being finalized and follows.

The second approach is based on best practicable means. In this case, the industry is free to adopt any suitable method which is technically feasible as well as economically viable. Such a system is prevalent in the United Kingdom. It may also be emphasized that the Environmental Protection Agency for the United States shifted the time bound standards for a specific period of time when confronted with the energy crisis.

The developing nations have also started organizing effective checks and controls on environmental pollution. In some case, suitable standards for water pollution have also been prescribed. However, detailed standards, for different industrial environments as well as for waste disposal, noise, air pollution, radioactive materials, etc., are yet to be developed. In each case, it is necessary to have a time bound programme for implementation of effluent treatment plan to meet the prescribed limits, and to consider the calculation of depth columns for dumping of radioactive waste, which will not come into contact with permanent water levels of the land. The site should be selected so that permeability and possibly of cap rock including container are fairly low to enable any appreciable diffusion. In case of tanneries, for example, the BOD of effluent varies from 7000 to 10,000 mg/l depending upon whether they are dealing with vegetable or chrome tanning or a combination of both the tanning operations. It is obviously difficult to immediately reduce BOD to 30 mg/l, which is the permissible limit for BOD, when the effluents are to be discharged into natural streams. Similarly, the situation in the case of distilleries is still worse because the BOD of the effluent is about 50,000 mg/l. In such cases, a suitable grace period is needed to enable the industry to develop suitable treatments for effluent disposal with prescribed limit.

The following suggestions could be helpful in proper environmental management: With regard to implementation, there are three possibilities.

(i) The first is to have statutory provisions and to declare that the level of pollutants, discharged into open streams beyond the desired limit, will invite

criminal proceedings or other suitable actions by the state. Thus, it will be mandatory to have as an integral part of each plant, a suitable device to reduce the level of each pollutant below the desired limit.

(ii) The second possibility is to leave the matter entirely to the industry, with certain guidelines so that they may adopt the best practicable methods available.

(iii) There is a third alternative which incorporates the advantages of both the methods but in any case a time bound programme will be needed.

1. There is no doubt that the 'best practicable means' approach offers a lot of freedom and has built-in flexibilities, which could be fully utilized for the benefit of the industry, and in the case of environmental management based on standards, it is essential for industry to follow the standards to avoid penal action.
2. In developing countries, about 80% people live in villages and are engaged in agriculture. The sanitary conditions prevalent in villages are far from satisfactory. A large migration of rural people from rural to urban areas due to 'urban pull' and 'rural push' is also responsible for poor collection of solid wastes on a large number of them do not have regular accommodation in the city. Sometimes, this collection does not even exceed 30%. Obviously, this balance creates the problem of soil pollution and, subsequently, water pollution due to run off, eventually joining a natural stream, and air pollution due to favourable meteorological conditions in tropical countries. Even climatic conditions are favourable to biodegradation of waste materials left-outside in tropical countries. It is, therefore, obvious that the situation in developing countries is different from that prevalent in developed nations, especially cold countries.
3. In the case of developing countries, there is increasing emphasis on small scale/ cottage/village industries, especially to contain unemployment. However, it is very difficult for small scale industries to have effective effluent treatment plant to meet prescribed limits of state pollution control board. They do not have expertise either for monitoring or for abatement of effluent. Further, they have resource constraint which also comes in their way in timely implementation of pollution control.
4. There is apparently some relationship between the size of the plant and the profit likely to be earned, especially due to scale economy. This also discourages the small-scale industry from going in for pollution abatement.
5. Extensive instrumental facilities to measure concentration of each pollutant are required, irrespective of the size of the industry, especially when the materials involved are the same. The expenses involved also prevent

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the small-scale industry from going in for scientific monitoring of each pollutant at regular interval.

6. Pollution abatement measures, except in the case of odour and noise, may not increase productivity, which is considered a plus point in favour of pollution abatement. The awareness, about loss in hearing, due to constant noise levels, has not yet been fully appreciated in developing countries, as this process is slow and its harmful effect has not yet been fully realized, it takes a fairly long time before hearing loss is appreciable.
7. The general standard of living is fairly low in developing countries. Hence, the flexibility offered by the 'best practicable means' approach may not be fully appreciated. On the other hand, it is likely to be misused. Even today, in most of the developing countries, statutory provisions for the monitoring of air, water, soil, noise and radioactive materials have not been laid down. In some countries, there is a provision for monitoring of important water streams at regular interval throughout a year. Surprisingly, scientific water treatment plants are not available everywhere, especially in third world countries. The absence of sophisticated instruments, required for proper monitoring of some of the pollutants, is another parameter responsible for delay in scientific monitoring.
8. What happened at Swansea Valley (England), where due to concentration of similar industries, especially with identical characteristics of effluent led to water and soil pollution and, consequently, the industrial activities came to a halt. This should be an eye opener to the scientific community and planners and should be kept in view while formulating policies for environmental management. Once pollution is left unchecked, there will be several closures like Swansea Valley industries.
9. The flexibility of the 'best practicable means' approach may lead to unnecessary litigation, causing delay and wastage of money in developing countries, due to difficulty in agreeable quantification of technical feasibility and economic viability, especially with relatively poor civic responsibility.
10. In the last five years, the standards for hexavalent chromium, mercury, lead, arsenic, cadmium, etc., have been reduced by several-fold. Obviously, this has been done due to better scientific understanding about their effects on human health. The studies conducted on a few important and common fishes, e.g., Mirgala Singala (Sihii), Mysturs Mystus (Tangri), Hetroponeust (Singhi), and Channagachua (Giri), have revealed that the distribution of heavy metals in different parts is not uniform.
11. As far as industrialization is concerned, there has not been geographical uniformity due to several constraints. Hence, the degree of pollution,

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which is directly linked to industrialization, is far from uniform. Thus, the total pollution load on each natural stream, at places, is different, suggesting different action in different situations. For example, in a region where there are a few industries, there is no point in being rigid about the concentration of different pollutants in the effluents being discharged into natural streams or in air. But in the case of heavily industrialized areas, the discharge of each industry should be carefully analysed because the total load on the natural stream would consist of individual loads. Hence, the idea of enforcing a uniform standard for different pollutants discharged into the natural stream in different areas does not appear to be scientifically and economically sound. Here, again it is necessary to have different standards for different zones.

In fact, wherever assimilation capacity is still available, further industrialization may be encouraged. But wherever the assimilation capacity has been surpassed due to heavy pollution, further industrialization, without-polluting industries, should be encouraged.

The state could be divided into three parts, Red, Grey and Green. Red area may be considered as that area where pollution load is more than assimilation capacity. Gray area may be considered for the part of the state where pollution load is less than 50% of the assimilation capacity. Green area may be considered that area where pollution load is within 25% of the assimilation capacity.

12. The ecosystem consists of the physical and biotic environment. The biotic environment consists of the animal kingdom, plant kingdom and human beings. The dynamic interaction among the three is very complex. Similarly, the impact of the physical environment on biotic environment is not yet well-understood. In the absence of any quantification of interactions between the physical environment and the biotic environment and different degree of pollution load, it is difficult to suggest realistic standards for different pollutants which are acceptable to polluters as well.
13. There is no proper justification for carrying out a detailed physico-chemical and biological analysis at different points in natural water streams. For example, in Uttar Pradesh, there is practically no point in finding out the radioactivity as there is practically no source. Secondly, there is no justification for carrying out a detailed chemical analysis as there is no source for some of the heavy metals, e.g., hexavalent chromium, lead, mercury, etc., at many places. The total biological analysis, as suggested in the prescribed standards, may not lead to meaningful information and may not effectively convey the position of a body of water, *i.e.*, river or lake, with regard to its pollutants.

In view of the points enumerated earlier, the following conclusion are obvious:

1. There should be statutory standards for air, water, noise, radioactive materials, etc. But due to the difficulties mentioned earlier, they should be implemented keeping in view the special situation, *i.e.*, circumstances associated with the industry and natural streams involved. Total pollution load on the river, its assimilation capacity and self-purification constant should be invariably considered.
2. The standards should serve as guidelines and there should be complete flexibility so that the pace of industrialization may be maintained or accelerated as far as possible. The global and regional requirements, and also economic conditions, may be kept in view while making statutory provision for the standards to be maintained by each industry. The practice of 'best practicable means', as adopted in the United Kingdom, and shifting of standards set by the Environmental Protection Agency of the United States are outstanding examples.
3. Wherever suitable technical know-how is not available, a grace period may be allowed and, in the meantime, suitable know-how may be developed with assistance from the polluting industry on the principle 'polluter should pay'. Further, as mentioned earlier, certain guidelines with regard to the desirable limits are necessary to know the exact position.
4. As an incentive, tax concessions may be given to those industries which maintain the standards, and a suitable penalty may be imposed on those which well above the prescribed limit, depending upon the degree of deviation from standards prevailing in the industry.

Thus, a flexible approach to environmental management, based on standards, should be adopted with, provision for detailed evaluation of technical feasibility and economic viability, jointly by polluters as well as enforcement agencies, so that both have faith in the evaluation, and the systems for effluent treatments, thus finalized, are implemented with full confidence.

Impact of Industrial Pollution

Materials which are mainly generated through anthropogenic activities and are discarded as useless or unwanted are called wastes. The waste may be solid, liquid and gaseous wastes. On the basis of the source of generation, they are classified as:

(1) domestic waste

(2) commercial wastes

(3) institutional waste

(4) agricultural waste

(5) biomedical waste and

(6) industrial waste

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The waste generated from the industrial sectors are known as industrial wastes. The industrial wastes are organic or inorganic in nature. Some of the wastes are:

(i) biodegradable or

(ii) non-biodegradable.

The wastes are also

(i) hazardous waste or

(ii) non-hazardous waste.

These wastes are generally discharged from the following:

(i) chemical industries

(ii) refineries

(iii) textile industries

(iv) drug industries

(v) fertilize plants

Bear in mind, a lot of there have been discussed in previous units.

All the wastes that are generated from industries have a greater effect on all living organisms, and especially the victims are the organisms in the local environment.

Wastes Polluting Air

The major air pollutants are:

(i) carbon oxides (CO and CO_2);

(ii) sulphur oxides (SO_2, SO_3);

(iii) nitrogen oxides (NO, NO_2, N_2O)

Particulate matter are root, smoke, very fine particles, such as lead, manganese, asbestor, arsenic, copper, zinc, etc.). Proxy acyl nitrate (PAN), Ozone(O_3), etc.

The industrial wastes polluting the air mainly come from the burning of fossil fuels in industries. Textile Industries produce the following air pollutants:

(i) Cotton dust

(ii) Nitrogen oxides

(iii) Chlorine

(iv) Smoke

(v) Sulphur dioxide

Fertilizer plants produce the following air pollutants:

(a) Oxides of sulphur

(b) Particulate matter

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(c) Ammonia nitrogen oxides

(d) Hydro carbon

Steel plants produce the following air pollutants:

(a) Carbon monoxide

(b) Carbon dioxide

(c) Sulphur dioxide

(d) Fluorine

(e) Particulate matter

The following are the effects of the major air pollutants:

1. Carbon monoxide combines with blood haemoglobin and forms stable carboxy haemoglobin, disturbing oxygen transportation and might cause death.
2. Oxides of nitrogen causes respiratory irritation, impairment of lung defence, bronchitis, loss of appetite, etc.
3. Sulphur dioxide causes suffocation, respiratory irritation, asthma and chronic bronchitis.
4. Particulate matter causes respiratory diseases, neural disorder and depending on the nature of element it might lead to cancer. If lead is present in the particulate matter and inhaled it might lead to mental retardation in children.
5. Ground level O_3 causes headache, suffocation and in external cases can be fatal.
6. Proxy acyl nitrate (PAN). PAN are produced nearer to the industry producing NO_2, volatile organic compound; through some mechanism this might be formed and effects local people severely by causing eye irritation, sore throat, respiratory irritation, headache, etc.
7. When lot of sulphur oxide particulate matter is formed then sulphurous smog might be formed which might lead to chronic bronchitis and acute respiratory problems.

Wastes Polluting Water

The major source of water pollution is industrial discharges especially from manufacturing plants. These industries discharge organics, such as toxic metals, pesticides, nitrate salts, etc. Ground water pollution can occur when industrial waste is discharged into pits, ponds or lagoons, thereby enabling wastes to percolate down to the water table. The oxygen demanding wastes are introduced from paper industry, textile industry, food processing plants, toxic metals, such as Hg,

Pb, Cd, Cr, Ni, etc., from the electroplating industry. The ground water pollution stems from disposal of wastes on or into the ground. The wastes, mainly in the rainy season, percolates into the ground and contaminate it. The typical pollutant sources are:

(i) industrial waste water impoundments,

(ii) sanitary land files,

(iii) storage piles which are improperly constructed.

The pollutants in water are limitless.

Some of them can be

(a) biochemical oxygen demanding wastes

(b) antimony

(c) cadmium

(d) chromium

(e) lead

(f) cobalt

(g) mercury

Generally, many industries, such as steel, paper industries are situated on the banks of rivers, as they require huge amounts of water in their operations. Such industries dump their wastes which contains acids, alkalis, dyes into the rivers. Many of these materials are poisonous for living organisms and causes serious water pollution problems.

Some of the effects of various pollutants are as follows:

1. **Oxygen demanding wastes —** With the increase of oxygen demanding wastes, the dissolved oxygen in water drops; threatening aquatic life. It loses its recreational quality and helps in the growth of pathogens making it completely unusable.
2. **Nutrients —** The industry, especially fertilizer industry, discharges a lot of nitrogen oxides which goes to water bodies through acid rain, and if larger concentration accumulates and local people use this water, their children might be effected with blue baby syndrome.
3. **Thermal pollution —** Steel industry, nuclear reactors, electric power plants use huge amount of water for cooling processes. The water discharged is very hot and causes thermal pollution. The high temperature depletes oxygen, fish and aquatic organisms get effected. The local people who depend on these water resources become affected. Again the cooling water produces waste water with salts.
4. **Heavy metals, Cd, Hg, Pb, As, etc. —** Heavy metals have great effect on human health as they may lead to kindly damage, disorder of liver, brain, genetic modification, skin cancer, causes cirrhosis.

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Wastes Polluting Land

Industrial wastes polluting land are generally wastes from the respective industrial establishments, such as:

(a) office and cafeteria wastes
(b) packing wastes
(c) tannery wastes
(d) dying wastes
(e) food processing wastes
(f) plastic wastes
(g) metal scraps
(h) pesticides

These wastes represent a health hazard due to their content in toxic substances, such as:

(i) heavy metals,
(ii) lead and cadmium,
(iii) pesticides,
(iv) solvents and used oil

The pollutants discharged into the soil can alter the chemical and biological properties of the soil. The toxic elements, such as lead, mercury, cadmium, etc., pose a detrimental threat, as they get into the food chain. The coal-based thermal power plants generates fly ash which gets deposited in the soil and causes serious pollution by changing the characteristics of the soil. The fly ash so formed carve the leaves of plants. And when the fly ash is inhaled, it causes serious health problems. An ideal example is the Kolaghat thermal power plant in Midnapore, where people are under serious conditions. Discarded plastics affect water resources in the local environment.

Wastes creating Noise Pollution

Noise is an unwanted sound energy and is considered as pollutant when it exceeds some limits. Noise pollution has been growing steadily mainly due to industrialization. Noise pollution has tremendous effect on the local environment. It disturbs and distracts. If the local people is exposed to it for a sufficient time, it causes physiological effects that may lead to deafness. Noise pollution may lead to cardiovascular problems like heart diseases and with blood pressure.

Managing Industrial Pollution

Urban and industrial wastes consist of medical waste from the following sources:

(a) Hospitals

(b) Municipal solid waste from homes
(c) Offices
(d) Markets (Commercial waste)
(e) Small cottage units.

Urban industrial wastes consist of horticultural wastes from the following sources:

(a) Parks
(b) Gardens
(c) Orchards

The urban solid waste materials that can be degraded by micro-organisms are called biodegradable wastes, for example:

(a) vegetable wastes
(b) stale food
(c) tea leaves
(d) egg shells
(e) peanut shells
(f) dry leaves

Wastes that cannot be degraded by micro-organisms are called non-biodegradable wastes, for example:

(a) polyethylene bags
(b) scrap metal
(c) glass bottles

Industrial waste consists of a large number of materials, including:

(a) factory rubbish
(b) packaging material
(c) organic waste and acids

There are large quantities of hazardous and toxic materials which are also produced during industrial processing.

Effects of Solid Wastes

Municipal solid waste heap up on the roads due to improper disposal system. People clean their own houses and litter their immediate surroundings, which affect the community, including themselves. This type of dumping allows biodegradable materials to decompose under uncontrolled and unhygienic conditions. This produces foul smell and breeds various types of insects and infectious organisms, besides spoiling the aesthetics of the site.

Industrial solid wastes are sources of toxic metals and hazardous wastes, which may spread on land and can cause changes in the physiochemical and the

biological characteristics, thereby affecting the productivity of soils. Toxic substances may leach or percolate and contaminate groundwater.

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Check Your Progress

8. What does the flexibility of the 'best practicable means' approach lead to?
9. What does the biotic environment consist of?
10. Which industries may be given tax concessions?
11. List two effects of major air pollutants.

11.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Excessive use of fuel wood and charcoal, expansion of urban, agricultural and industrial areas and overgrazing have together led to overexploitation of our forests leading to their rapid degradation.
2. Deforestation has far reaching consequences, which may be detailed as follows:
   - It threatens the existence of many wild life species due to destruction of their natural habitat.
   - Biodiversity is lost and along with that genetic diversity is eroded.
3. Minerals that exist relatively deep underground (eg. some coal seams, gold and some metalliferous ores) are generally recovered using underground mining methods.
4. Hazardous waste of hospitals contains pathogens, chemicals and substances which could be harmful to humans and the environment if not disposed of properly.
5. Small waste treatment includes changing the pH level to reduce its acidity or performing small-scale chemical reactions to prevent occurrence of dangerous reactions later on.
6. The best method for disposing infectious hazardous waste is incineration or any other thermal technique.
7. The Convention has the objectives of prevention and minimization of hazardous waste generation, environmentally appropriate management of these wastes, and the promotion and use of cleaner technologies.
8. The flexibility of the 'best practicable means' approach may lead to unnecessary litigation, causing delay and wastage of money in developing countries, due to difficulty in agreeable quantification of technical feasibility and economic viability, especially with relatively poor civic responsibility.

9. The biotic environment consists of the animal kingdom, plant kingdom and human beings.
10. As an incentive, tax concessions may be given to those industries which maintain the standards, and a suitable penalty may be imposed on those which well above the prescribed limit, depending upon the degree of deviation from standards prevailing in the industry.
11. The following are the effects of the major air pollutants:
    - Carbon monoxide combines with blood haemoglobin and forms stable carboxy haemoglobin, disturbing oxygen transportation and might cause death.
    - Oxides of nitrogen causes respiratory irritation, impairment of lung defence, bronchitis, loss of appetite, etc.

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11.6 SUMMARY

- Forests provide us a large number of commercial goods which include timber, firewood, pulpwood, food items, gum, resins, non-edible oils, rubber, fibres, lac, bamboo canes, fodder, medicine, drugs and many more items.
- Forested watersheds act like giant sponges, absorbing the rainfall, slowing down the run-off and slowly releasing the water for recharging of the springs.
- The community-based forest management systems in Orissa and elsewhere in India vary, depending on the condition and diversity of the local resources. In Puri district, where the Binjgiri forest is located, the great scarcity of natural resources led to the creation of BOJBP.
- Environmental awareness increased dramatically in the 1990s in India and so did the number of organized lobbies to champion the cause of a cleaner environment. As a result, New Delhi introduced legislation aimed at curbing pollution, but the enforcement mechanism has been [lacking].
- Commercial timber operations received a boost when laboratory trials at the Forest Research Institute showed that the utilization of chir waste (the material after the conversion of logs to railway sleepers) for making paper was a viable proposition, and when further research at the FRI established that ash and hornbeam could be used for the manufacture of sports goods.
- The need for mineral extraction and production is an essential activity of any technically proficient society. As minerals are produced from within a naturally occurring environment, disturbance of the environment as a result of mineral production is a given.
- The crusade against the ecological damage and deforestation caused due to Tehri dam was led by Shri Sunderlal Bahaguna, the leader of Chipko Movement. The cause of Sardar Sarovar Dam related issues taken up by

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the environmental activitist Medha Patkar, joined by Arundhati Roy and Baba Amte.

- Knowing about the components that are hazardous in a waste is only one aspect of hazardous waste management. Identification of hazardous waste source is also very crucial to its proper management.
- Hazardous waste storage is a time-bound process. After its generation, the waste is stored at the source site for certain duration before its transportation to a disposal site.
- The Ministry of Environment and Forests (MoEF), Government of India issued a notification on 28 July 1989, which informed that the Hazardous Waste (Management & Handling) Rules (HWM Rules) will deal with wastes which are not covered under the Water and Air Acts.
- As a result of the amendments made in 2000 and subsequently in 2003, the State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) have undertaken the process of re-inventorizing hazardous waste generated.
- Persistent organic pollutants and toxic materials, such as pesticides and industrial wastes can accumulate in living tissues disrupting endocrine systems, suppressing immunity functions and causing reproductive and developmental changes.
- In developing countries, *P*3 syndrome (population, poverty and pollution) is the key factor for rapid environmental degradation, whereas in developed countries it is the high rate of per capita resource used which leads to such a degradation.
- In the case of developing countries, there is increasing emphasis on small scale/ cottage/village industries, especially to contain unemployment. However, it is very difficult for small scale industries to have effective effluent treatment plant to meet prescribed limits of state pollution control board.
- Even today, in most of the developing countries, statutory provisions for the monitoring of air, water, soil, noise and radioactive materials have not been laid down. In some countries, there is a provision for monitoring of important water streams at regular interval throughout a year.
- The ecosystem consists of the physical and biotic environment. The biotic environment consists of the animal kingdom, plant kingdom and human beings. The dynamic interaction among the three is very complex.
- Particulate matter causes respiratory diseases, neural disorder and depending on the nature of element it might lead to cancer. If lead is present in the particulate matter and inhaled it might lead to mental retardation in children.
- The major sources of water pollution is industrial discharges especially from manufacturing plants. These industries discharge organics, such as toxic metals, pesticides, nitrate salts, etc. Ground water pollution can occur when

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industrial waste is discharged into pits, ponds or lagoons, thereby enabling wastes to percolate down to the water table.

- Steel industry, nuclear reactors, electric power plants use huge amount of water for cooling processes. The water discharged is very hot and causes thermal pollution.
- The pollutants discharged into the soil can alter the chemical and biological properties of the soil. The toxic elements, such as lead, mercury, cadmium, etc., pose a detrimental threat, as they get into the food chain.

11.7 KEY WORDS

- **Deforestation:** It refers to the clearing of forest lands for other uses.
- **Hazardous waste:** Hazardous waste of industries contains chemicals and toxic substances that can be very harmful to humans and surroundings which are exposed to them.
- **Industrial Pollution:** Industrial pollution refers to the pollution of our environment by industrial wastes, which are harmful in the long-run.
- **Biodegradation:** It is the naturally-occurring breakdown of materials by microorganisms such as bacteria and fungi or other biological activity. Composting is a human-driven process in which biodegradation occurs under a specific set of circumstances.

11.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. List any two major causes of deforestation.
2. What are the things to be considered while transporting hazardous waste?
3. Why should storage containers be resistant to any reaction with hazardous waste?
4. List the main causes of environmental degradation by mankind.
5. How does total environmental degradation and pollution as proposed by eminent physicist John Holdern and biologist Paul Ehrlich arise?
6. List any two effects of water pollutants.

Long-Answer Questions

1. Discuss the ecological services provided by forests.
2. Analyse the characteristics of hazardous waste.
3. Describe the basic procedure that needs to be followed for safe disposal of hazardous waste.

11.9 FURTHER READINGS

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BLOCK IV
PROTECTION OF ENVIRONMENT MOVEMENT

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UNIT 12 MAJOR ENVIRONMENT MOVEMENTS IN INDIA-I

Structure

12.0 INTRODUCTION

The United Nations Conference on Human Environment, Stockholm, 1972 paved the way for a number of studies and reports on the condition of the environment and its effect on the present and future generations. It expressed concern to protect and improve the environment for present and future generations. The development of 'green politics' or 'eco-greens' or the 'green movement' in Germany and North America in the early 1980s boosted the formation of the 'green network' and the 'green movement' throughout the world, including India.

A number of action groups, research institutes, documentation centres have been established to study and mobilize public opinion on environmental issues. By now, the material on the environmental situation in general and in certain sectors such as air, land, forest, water, marine resources, etc., have proliferated in different forms from popular literature to 'scientific' studies. The reports on India's environment published by the Centre for Science and Environment provide valuable material not only on various aspects of the environment but also people's resistance and struggles. The media also frequently reports on struggles of the people at the local level on the issues of land, water, marine resources, forest products, etc. However, systematic analytical research-based monographs on environmental movements are few and far between. In this unit, you will learn about the major environment movements in India including the Chipko movement and the Silent Valley movement.

12.1 OBJECTIVES

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After going through this unit, you will be able to:

- Explain the concept of environment movements
- Discuss the origin and achievements of Chipko movement
- Describe the reasons behind the Silent valley movement

12.2 INTRODUCTION TO ENVIRONMENT MOVEMENTS

More often than not, the struggles of the people on the issues of their livelihood and access to forest and other natural resources are coined as 'environmental movements'. Historical studies on peasant movements mainly focus on the agrarian relationship between different classes of landowners. Studies on the struggles over forest resources are treated as tribal movements. Guha and Gadgil rightly observe, 'The agrarian history of British India has focused almost exclusively on social relations around land and conflicts over distribution of its produce, to the neglect of the ecological context of agriculture for example, fishing, forests, grazing land and irrigation and of state intervention in these spheres'.

Among the few important studies focusing on one's of the important themes of the movements are those on the Chipko movement by Ramachandra Guha and Narmada Bachao Andolan (NBA) by Amita Baviskar. Both the authors, however, do not want their studies to be treated as mainly on environmental movements. Guha calls his study on peasant resistance focusing on the ecological dimension. It is a study on the ecological history of the region linking 'environmental changes with changing and competing human perceptions of the "uses" of nature'. The study is focused on the structures of dominance and the idioms of social protest. He analyses ecological changes and peasant resistance in the Himalayas in the wider comparative framework. Baviskar studied the tribals of Madhya Pradesh, focusing on their relationship with nature and their conflicts over state-sponsored 'development'. She interrogated the theoretical positions of the environmental movements which assert that the 'development' paradigm of the dominant elite, followed by the Indian state, is environmentally destructive. These movements claim that their critique 'is writ large in the actions of those marginalized by development-indigenous people who have, in the past, lived in harmony with nature, combining reverence for nature with sustainable management of resources. Because of their cultural ties with nature, indigenous people are exemplary stewards of the land'. She analysed the socio-cultural life of the tribals and their resistance to 'development'. She also probed into the question: Given the problematic nature of tribal resource use, how accurately are the lives of tribal people represented by intellectuals in the environmental movement who speak on their behalf?

Guha and Gadgil provide a very valuable overview delineating conflict over forest produce, forest land and pasture land in different parts of colonial India. They discuss the resistance of hunt-gatherers and shifting or *jhum* cultivators to the state intervention in settled cultivation. Forest dwellers launched *satyagrahas* during the 1930s against the forest departments on the issue of encroachment of land. Similar confrontations increased during the post-independence period. Shiva and Bandopadhyaya inform us that about three centuries back the Vishnois of Khejri village in Rajasthan sacrificed more than 200 lives in a passive resistance to the felling of green trees by the royal forces from Jodhpur. There were similar instances in which farmers and forest-dwelling communities resisted the destruction of forest resources. These evidences show a wide range of conflict between the authorities, particularly the forest department and the communities residing in the forests. Shiva and Bandopadhyaya argue that 'these conflicts may not always take the form of people's ecology movements that hold the possibility of resolving these conflicts in just manner. They may also get distorted to take the form of other social conflicts like communal politics, which may not hold the possibility of resolution of the material conflicts'.

Forest struggles may be divided into two; those that were a reprise to direct commercial exploitation and those that were a response to commercial exploitation legitimized as 'scientific forestry'. The dominant strata use scientific forestry as a political weapon to legitimize overexploitation of resources for profit. There is conflict between the profitability and survival imperatives. The latter is being challenged by the action groups supporting the poor by reinterpreting science for public interest.

Baviskar analyses the development policy and performance of the Indian state. She finds that poor people's ability to control and gainfully use natural resources has declined in the last five decades of the development policies. She argues that the model of development, established since independence, has fundamentally altered the way in which different social groups use and have access to natural resources. The changes wrought by the independent state have created conflicts over competing claims to the environment. These conflicts range from the incessant battle between the forest department and local communities, to the war, raging between mechanized trawls and traditional fishing boats in India's coastal waters, to the controversy over the Dunkel Draft and rights to genetic resources. These claims are not merely for a greater share of the goods, but involve different ways of valuing and using nature for profit or survival, or some combination of the two. They also involve different world views one driven by the desire to dominate and exploit nature and humanity, the other moved by empathy, and respect, sometimes reverence, for the two.

Broadly speaking, the theme of the man-nature relationship is central to environmental movements. Guha and Gadgil define the environmental movement 'as organized social activity consciously directed towards promoting sustainable use of natural resources, halting environmental degradation or bringing about

environmental restoration.' In the West, environmental movements focus on consumption, productive use of natural resources and conservation or protection of natural resources. In India, the movements are based on use and alternative use of, as well as control over natural resources. Jayanta Bandopadhyaya and Vandana Shiva observe that ecology movements in independent India have increased against 'predatory exploitation of natural resources to feed the process development' which is dominated by market forces. Such a process has threatened the survival of the poor and powerless. They argue that 'the ecology movements in India are the expression of protests against the destruction of the two vital economics of natural processes and survival from the anarchy of development based on market economy. These movements have unfolded the contradictions between India and its three economies: those revolving around the market, the household, and nature'.

Harsh Sethi classifies the struggles into three categories broadly und their ideological approach to the issue of environment. One, the struggles which operate in the domain of political economy, raises the issue of rights and distribution of resources. Second, the movements confined to a response to environmental problems and seeking solutions within existing socio-economic frameworks and technological innovations. They seek legal and policy-based shifts in the pattern of resource use. Third, some environmental movements reject the dominant development paradigm and 'seek to alter the very classification of both man and nature relationship'.

Guha and Gadgil classify movements on the basis of the participants. According to them there are three categories of members: 'omnivores, ecosystem people and ecological refugees'. In this multiplicity of movements, one may discern seven major strands. Two of these are exclusively focused on nature conservation, one on aesthetic/recreational/scientific grounds and the others on the basis of cultural or religious traditions.

A third strand confines itself to the technological perspective focusing on the efficiency of resource use. According to them the question of equity is the dominant concern of the environmental movements in present day India. They are concerned with 'environmentalism' related to the poor. In terms of their ideology there are four strands within these movements. They are: 'crusading Gandhians, ecological Marxists, appropriate technologists, scientific conservation and wilderness enthusiasts'. According to the crusading Gandhians, eastern society, unlike the west, is primarily non-materialist. They are against industrial growth brought by the colonial rule. They frequently cite Hindu scriptures as exemplifying a 'traditional' reverence for nature and life forms.

Harsh Sethi divides the environmental struggles into five categories:

1. **Rest-based:** Forest policy, use of forest resources, etc.
2. **Land use:** Industrialization and loss of agriculture land, indiscriminate popularization chemical inputs resulting in degradation of land and water logging, exploitation of mineral resources;

(i) Against big dams involving the problem of involuntary displacement of tribals and non-tribals, residing in the upstream of the river, environmental degradation, including destruction of forests;

(ii) Against pollution created by industries and

(iii) Against overexploitation of marine resources.

Environmental movements raise a variety of issues both in rural and urban areas related to forest, agriculture, industrial pollution, nuclear tests, tourism, etc. There are a number of non-government organizations (NGOs) who protest against environmental degradation and hazards. Besides pressurizing the political authorities and dominant groups such as industrialists, planners, etc., they also campaign for creating awareness among people on the issues of environment. Organizations like the Kerala People's Science Movement (KPSM) try to demystify the science created by a dominant group of scientists. It advocates sustainable development. The KPSM organizes *padyatras* to develop consciousness for a people-oriented environment. Several other groups also follow the same strategy. They disseminate literature related to pollution, land degradation, loss of natural resources, etc. Occasionally some groups resort to public interest litigation in the courts to stop certain government and private projects which adversely affect not only the health and other aspects of the people but also the livelihood of the marginalized groups.

In struggles around the issues of forest resources and their use, the main participants have been the tribals and other peasant communities depending on forest resources for their survival. They resist state intervention which impinges on their rights and control over resources. The forms of resistance and occasional confrontations vary from outmigration to evasion of responsibilities, robberies to murders. According to Guha, in the traditional system it is considered that it was the responsibility of the rulers to protect the customary rights and interests of his subjects. When the ruler fails to do so or impinges on the rights of the people, the resistance and revolt are 'traditionally sanctioned by custom'. In Tehri Garhwal, the mechanism of social protest 'drew heavily on the indigenous tradition of resistance known as *dhandak.* Yet, for all its distinctiveness, the *dhandak* is a representative of a type of rebellion that was widely prevalent in pre-industrial and pre-capitalist monarchies'. When the traditional custom of resistance does not remain effective with the changed reality, people resort to confrontation.

Popular Movements in India

As mentioned earlier, some of the popular movements in India are: Chipko movement, silent valley movement Narmada Bachao Andolan, Koel Karo movement and appiko movement.

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Check Your Progress

1. What are the two ways in which forest struggles may be divided?
2. What do environmental movements focus on in the West and in India?

12.3 CHIPKO MOVEMENT

Since the time of the British raj, the Himalayan mountain region have been famous the world over for its innate wealth, whether minerals or timber. In the 19th century, new techniques in forestry, as well as the policy of the colonial government of advocating forest related businesses disturbed the age-old symbiotic association that existed between the natural environment and the rural peasant, both in Kumaon and Garhwal. The few demonstrations that were held by the peasants of the region were brutally suppressed. Some of the notable protests in the region in pre-independence India included protests in 1906, followed by demonstrations in 1921. The 1921 protests are significant since they were associated with the freedom struggle that Gandhi was leading against the British. A series of protests also occurred in the 1940s in the Tehri Garhwal region of the Himalayas.

After India gained independence from British colonial rule, the upper regions of the Himalayans were largely left untouched. However, all of this changed after the 1962 Indo-China war, a war in which India was soundly trounced by the Chinese. Although the Garhwal region was not affected by the war, after India's defeat, the Indian army started taking steps to protect its borders with China in the Garhwal region. The army set up bases and built roads on the upper reaches of the Garhwal region, an area that in the past was largely disconnected from the rest of India.

The building of roads in the region eventually led to mining, of limestone, magnesium and potassium. Along with miners, came the timber merchants. Almost immediately, the forests of the region began to deteriorate at a frightening rate, which led to difficulties for those Garhwalis who were involved gathering fodder and firewood. Rampant deforestation and mining also deteriorated the state of the soil, soil erosion also occurred as water sources in the region dried up. In fact, water shortages in the region became extensive. The communities of the region gave up raising livestock, which led to increase in malnutrition. The crisis that the communities were facing was accentuated by the fact that the colonial era Indian Forest Act, 1927, restricted the admittance of the communities of the region to the region, which resulted in farmlands becoming scarce in an area that had become populated, yet remained desperately poor in spite of all the natural wealth. In the 1960s, the destruction of the local agrarian economy resulted in the migration of many of the people of the regions to the plains.

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Slowly a rising awareness about the ecological crisis in the region, which came from the immediate loss of livelihood of the people, resulted in the development of political activism in the area. In 1964, the Dasholi Gram Swarajya Sangh (DGSS) ('Dasholi Society for Village Self-Rule'), was established by Gandhian social worker, Chandi Prasad Bhatt in Gopeshwar. Bhatt was motivated by J.P. Narayan's Sarvodaya movement, and wanted to set up small industries employing the resources of the forest. Their first project was an undersized workshop making farm tools for local use.

The organization faced a lot of challenges while carrying out their work. These included colonial era forest policies that were widespread, as well as the contractor system, in which large areas of the forest were treated as commodities and sold off to large contractors, who were generally from the plains. These large contractors brought with them their labour, leaving only basic jobs like hauling rocks to the hill people, and paying them very less. More and more people from the plains started arriving in the region, which strained the already fragile environmental balance. Due to all of these reasons, the Garhwal region soon became the focal point of the increasing ecological consciousness of how deforestation had reduced a lot of the woodland cover, which directly led to the devastating 1970 July floods on the Alakananda River. During the floods, a huge landslide resulted in the river being blocked, and effected an area beginning from Hanumanchatti, near Badrinath to 350 km downstream until Haridwar. Many roads, and villages were wiped out in the floods.

After the Alakananda river floods, landslides became a common occurrence in the area. There was also a rise in civil engineering projects. Almost immediately after the floods, people of the region, especially women, began to organize themselves in small groups in opposition to deforesting operations in the region that were affecting their livelihoods. In October 1971, DGSS workers held a protest in Gopeshwar to object to the policies of the Forest Department. More demonstrations were organized until 1972, but they had little effect, thus a decision was taken to take direct action.

The first such juncture came up when the Forest Department turned down DGSS request for ten ash trees yearly for its farm tools workshop, and instead awarded a contract of 300 trees to a sporting goods company so that they could make tennis racquets. The decision was met with huge protests. When lumbermen of the company came to cut down the trees, they were met with a mass of people beating drums and shouting slogans. The lumbermen were forced to withdraw; the contract was eventually cancelled and awarded to the DGSS as an alternative.

However, by this time, the issue had gone beyond yearly quotas of tree felling, and encompassed the larger issue of businesses related to logging of trees as well as the government's forest policy, which the people of the region felt were unfavourable to them. The DGSS decided to initiate a campaign of 'chipko' or hugging trees, as a method of non-violent demonstration.

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Fig. 12.1 *Chipko Movement*

The movement continued to have many clashes with the administration. A few months after the contract for felling 300 trees awarded to a sporting goods company was cancelled, the same company was given a contract to fell more trees in another area. Once again, because of opposition of the local people, beginning on 20 June 1973, contractors withdrew after a confrontation that lasted a few days. Afterward, nearby villages set up a vigil group and watched over the trees until December to ensure they were not felled. In December another confrontation occurred, and once again the contractors were forced to withdraw.

The final point started a few months afterwards, when the government declared an auction scheduled in January 1974, for 2,500 trees near Reni village, overlooking the Alakananda River. The leader of the DGSS Bhatt called on the villages in the Reni area to protest against this decision. The villagers in the region responded by hugging trees to prevent them from being cut down. For next few weeks, rallies and meetings were held in the Reni area against the government's decision.

On 26 March 1974, people from the nearby villages of nearby villages and DGSS workers were in Chamoli were directed by the state government and contractors to an imaginary compensation payment site, while loggers began arriving in Reni village to fell trees. A local girl, on seeing them, hurried to inform Gaura Devi, the head of the village Mahila Mangal Dal, at Reni village. Devi led twenty-seven of the village women to the spot and confronted the loggers. When all conversation failed, and instead the loggers began to shout and mistreat the women, threatening them with guns, the women chose to hug the trees to stop them from being felled. This went on till late hours. The women kept an all-night vigil protecting their trees from the cutters until a few of loggers relented and left the village. The

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next day, when the men and leaders came back, the news of the struggle spread to the neighbouring Laata and others villages including Henwalghati, and additional number of people joined in. In the last, only after a four-day confrontation, the contractors left.

Aftermath

After this incident, the then state Chief Minister, Hemwati Nandan Bahuguna, set up a commission to look into the matter. The commission ruled in favour of the villagers. This result became a defining moment in the history of environmental movements in India, and indeed, around the world.

After the success, the movement spread to other areas of the region. Impulsive confrontations between the local people and timber merchants took place at several locations, with the women of the hill region showcasing their new-found power as nonviolent activists. As the movement acquired shape under its leaders, the name Chipko movement was attached to their activities. Within a decade, the movement had spread to the entire Uttarakhand Himalayan region. Bigger issues of ecological and economic development of the region were raised.

The movement now demanded that no forest-exploiting bonds should be given to external people and local communities should have useful control over natural resources like land, water and forests. They also demanded that the government provide inexpensive materials to small industries and ensure the growth of the region without disturbing the delicate environmental balance. The movement also decided to take up the economic problems of landless forest workers and demanded guarantees of minimum wage for them. Internationally, the Chipko movement showed how environment causes, up until then assumed to be an activity of the rich, were a topic of life and death for the poor. The poor after all the first to be affected during an environmental tragedy. Several scholarly studies were conducted regarding the consequences of the movement. In another notable movement, in 1977, women in a nearby region, started tying rakhis on trees earmarked for logging.

The involvement of women in the Chipko movement was one of its most significant aspects. The contractors who felled trees were also the suppliers of liquor to men of the area. The women of the movement decided to broaden the campaign to other social evils like alcoholism. A great victory was won by the movement when in 1980, the then Prime Minister Indira Gandhi completely banned the felling of trees in the region for a period of 15 years until the green cover of the region was completely restored. One of the most notable leaders of the Chipko movement Gandhian Sunderlal Bahuguna, undertook a 5,000-kilometre trans-Himalaya foot march in 1981–83, to an effort to extend the message of the Chipko movement to a far greater area. Slowly, women set up cooperatives to guard local forests, and also held fodder production at rates favourable to the local environment. They also participated in land rotation plans for fodder collection, helped replant degraded land and set up and ran nurseries stocked with species they chose.

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Fig. 12.2 *Sunderlal Bahuguna*

In the Chipko movement, both men and women played pivotal roles. Some of the important leaders of the movement included activists like Gaura Devi, Sudesha Devi, Bachni Devi, Chandi Prasad Bhatt, Sundarlal Bahuguna, Govind Singh Rawat, Dhoom Singh Negi, Shamsher Singh Bisht and Ghanasyam Raturi, the Chipko poet, whose songs echo throughout the Himalayas. Chandi Prasad Bhatt was awarded the Ramon Magsaysay award in 1982 for his work in the chipko movement, while Sundarlal Bahuguna was awarded the Padma Vibhushan in 2009.

Check Your Progress

3. When and why was the Dasholi Gram Swarajya Sangh established?
4. Mention some of the important leaders of the Chipko movement.

12.4 SILENT VALLEY MOVEMENT

Silent Valley is situated in Palghat district in Kerala. It is of significant value since it contains the last critical stretch of tropical evergreen forest in India. In fact, its value comes from the fact that it is the only remnant of near virgin forest in the entire Western Ghats. It is estimated to have a continuous record of not less than 50 million years of evolution. The name Silent Valley rose to prominence when the Save Silent Valley Movement was started by NGOs, the scientific community and conservation activists with social awareness. The movement was started against the decision to establish a hydroelectric project in the areas which would have otherwise submerged 830 hectares of pristine and ecologically important tropical rainforests.

The decision to build a dam on the Kunti River was initiated by the British government in pre-independence India. The Kunti river originates from the Silent Valley forest. Due to some reasons, the project was not implemented at that time. Post-independence, the first survey of the proposed hydroelectric project was

conducted in 1951 by the state government. The project plan was later approved by the Planning Commission of India in 1973 .

The uniqueness of Silent Valley is that it harbours close to 108 varieties of the flower Orchid. The forest also boats of a variety of medicinal plants, with 80% of the medication recorded in standard Pharmacopeias. Also, 66 percent of the species and aromatic plants are famous all over the world . Given that these are rainforests, it is also a significant pool of generically variant plant and animal species. It will be interesting to note that there are close to twenty-one flower plants which are considered new to Science. Not just in plant species, the silent valley is crucial from the animal species' perspective too. There are close to twenty-three mammalian species in the region. Endangered species like the Nilgiri Langur, Tiger and Lion-followed Macaque have also been found in the valley.

Understanding the importance of the valley, many teachers and Scientists joined hands to launch many protests against the proposed dam. Due to the protests, a stay was put on the project in 1976 by the National Committee on Planning and Coordination (NCEPC). The Committee recommended that a study be conducted to understand the effects of the project on the region. Many environment-based societies too came forward to request the cancellation of the project all together like the Kerala Natural History Society and Bombay Natural History in 1978. It is pertinent to mention here the crucial report presented by the people's science movement group Kerala Sastra Sahitya Parishad. The group detailed the damning social, natural and financial costs of the proposed dam. The government, both state and centre too constituted committees like the M S Swaminathan Committee and Dr MGK Menon Committee both of which considering the ecological damage to the rich region recommended that the project be scrapped.

In the middle of the movement, there were a lot of activities and missions driven by KSSP as well as student teacher organizations. Silent Valley Movement may very well be called the first ever movement across the Indian history, in which there has been participation of famous and well known writers who joined the battle for the cause of environment. They made use of various mediums like stories, poems, shows, dramas, songs and kavi sammelans to pass on the message to the Kerala's educated public.

The allies of the hydro-electric project contended that the individuals who restrict the construction of dam project were against the country's development and favoured monkeys instead of the people! The Kerala State Electricity Board (KSEB) pointed the low unit cost of electricity offered by the high watershed of Silent Valley through the proposed project which would have covered four regions of Malabar.

The discussions and protests continued for quite a while and finally in 1983, the then Prime Minister Mrs. Indira Gandhi advised that the State government to cancel the project. She also named Silent Valley as a National Park. The National Park was opened in 1985.

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Significance

The Silent Valley Movement was the continuation of the development related issues which had just begun in India with the Chipko movement in the 1970s. The success of the movement presented another view of development which guarantees sustainability and protected the privileges of the non-human world. Particularly in Kerala, this environment movement made public mindful of the fact that the development which sought to hurt the climate in the present moment will antagonistically influence the social and monetary existence of things to come in the future times. The debate of choice between development and monkey and the triumph of the non-human species in the Silent valley movement demonstrated the way that the non-human world has a similar rights on earth as humans.

The tendency of this movement towards the left reworked the Marxist idea of nature as an asset to nature as a fortune which must be protected and preserved. The philosophical split inside the Marxist party with respect to the Silent valley movement was the perception of development. It was indeed a very crucial yet supremely difficult task for the KSSP to teach the nearby locals and communities, who were entranced by the advantages of the modern project and the employment it would generate, the importance of the rainforests, and the long term need to protect it. The awareness activities undertaken KSSP and different groups highlighted the fact that without protecting and conserving the nature we can't protect or develop ourselves. In the history of environmental movements in the country, the accomplishments of Silent Valley movement had an influence on the individuals and motivated them to challenge the ecological injustices which were happening in their region. The movement also a good example of leading a non-violent Gandhian style movement for the protection of the environment and ecology.

The Silent Valley movement became a meeting place for various different thoughts with respect to the perception of development and the administration and use of natural resources. KSSP which was a prominent body in the movement itself distributed a lot a few leaflets and studies about the issue. One of the significant leaflets, *The Silent valley Project: Parishad's Stand and Explanation* contended that 'the Silent Valley issue raised some serious concerns like people's attitude towards development, the conflict between various interest groups, the development of Palghat- Malappuram districts, providing adequate amount of energy to the Malabar zone, the electricity generating policies of Kerala government etc.'

Check Your Progress

5. Where is Silent valley located and what is its significance?
6. When was the project plan in the Silent Valley approved?
7. What did Indira Gandhi advice about the Silent valley hydro-electric project?

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12.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. Forest struggles may be divided into two; those that were a reprise to direct commercial exploitation and those that were a response to commercial exploitation legitimized as 'scientific forestry'. The dominant strata use scientific forestry as a political weapon to legitimize overexploitation of resources for profit. There is conflict between the profitability and survival imperatives. The latter is being challenged by the action groups supporting the poor by reinterpreting science for public interest.
2. In the West, environmental movements focus on consumption, productive use of natural resources and conservation or protection of natural resources. In India, the movements are based on use and alternative use of, as well as control over natural resources.
3. In 1964, the Dasholi Gram Swarajya Sangh (DGSS) ('Dasholi Society for Village Self-Rule'), was established by Gandhian social worker, Chandi Prasad Bhatt in Gopeshwar. Bhatt was motivated by J.P. Narayan's Sarvodaya movement and wanted to set up small industries employing the resources of the forest. Their first project was an undersized workshop making farm tools for local use.
4. In the Chipko movement, both men and women played pivotal roles. Some of the important leaders of the movement included activists like Gaura Devi, Sudesha Devi, Bachni Devi, Chandi Prasad Bhatt, Sundarlal Bahuguna, Govind Singh Rawat, Dhoom Singh Negi, Shamsher Singh Bisht and Ghanasyam Raturi, the Chipko poet, whose songs echo throughout the Himalayas.
5. Silent Valley is situated in Palghat district in Kerala. It is of significant value since it contains the last critical stretch of tropical evergreen forest in India. In fact, its value comes from the fact that it is the only remnant of near virgin forest in the entire Western Ghats.
6. The project plan was approved by the Planning Commission of India in 1973.
7. In 1983, the then Prime Minister Mrs. Indira Gandhi advised that the State government to cancel the project. She also named Silent Valley as a National Park.

12.6 SUMMARY

- More often than not, the struggles of the people on the issues of their livelihood and access to forest and other natural resources are coined as 'environmental movements'. Historical studies on peasant movements mainly

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focus on the agrarian relationship between different classes of landowners. Studies on the struggles over forest resources are treated as tribal movements.

- Forest struggles may be divided into two; those that were a reprise to direct commercial exploitation and those that were a response to commercial exploitation legitimized as 'scientific forestry'. The dominant strata use scientific forestry as a political weapon to legitimize overexploitation of resources for profit. There is conflict between the profitability and survival imperatives. The latter is being challenged by the action groups supporting the poor by reinterpreting science for public interest.
- Broadly speaking, the theme of the man-nature relationship is central to environmental movements. Guha and Gadgil define the environmental movement 'as organized social activity consciously directed towards promoting sustainable use of natural resources, halting environmental degradation or bringing about environmental restoration.' In the West, environmental movements focus on consumption, productive use of natural resources and conservation or protection of natural resources. In India, the movements are based on use and alternative use of, as well as control over natural resources.
- Jayanta Bandopadhyaya and Vandana Shiva observe that ecology movements in independent India have increased against 'predatory exploitation of natural resources to feed the process development' which is dominated by market forces.
- Guha and Gadgil classify movements on the basis of the participants. According to them there are three categories of members: 'omnivores, ecosystem people and ecological refugees'. In this multiplicity of movements, one may discern seven major strands. Two of these are exclusively focused on nature conservation, one on aesthetic/recreational/scientific grounds and the others on the basis of cultural or religious traditions.
- A third strand confines itself to the technological perspective focusing on the efficiency of resource use. According to them the question of equity is the dominant concern of the environmental movements in present day India.
- Environmental movements raise a variety of issues both in rural and urban areas related to forest, agriculture, industrial pollution, nuclear tests, tourism, etc. There are a number of non-government organizations (NGOs) who protest against environmental degradation and hazards. Besides pressurizing the political authorities and dominant groups such as industrialists, planners, etc., they also campaign for creating awareness among people on the issues of environment.
- In struggles around the issues of forest resources and their use, the main participants have been the tribals and other peasant communities depending on forest resources for their survival. They resist state intervention which impinges on their rights and control over resources.

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- Some of the popular movements in India are: Chipko movement, Save Silent Valley, Narmada Bachao Andolan, Koel Karo and Appiko Movement.
- After India gained independence from British colonial rule, the upper regions of the Himalayans were largely left untouched. However, all of this changed after the 1962 Indo-China war, a war in which India was soundly trounced by the Chinese.
- The building of roads in the region eventually led to mining, of limestone, magnesium and potassium. Along with miners, came the timber merchants. Almost immediately, the forests of the region began to deteriorate at a frightening rate, which led to difficulties for those Garhwalis who were involved gathering fodder and firewood.
- When the government declared an auction scheduled in January 1974, for 2,500 trees near Reni village, overlooking the Alakananda River. The leader of the DGSS Bhatt called on the villages in the Reni area to protest against this decision. The villagers in the region responded by hugging trees to prevent them from being cut down. For next few weeks, rallies and meetings were held in the Reni area against the government's decision.
- On 26 March 1974, people from the nearby villages of nearby villages and DGSS workers were in Chamoli were directed by the state government and contractors to an imaginary compensation payment site, while loggers began arriving in Reni village to fell trees.
- The women kept an all-night vigil protecting their trees from the cutters until a few of loggers relented and left the village. The next day, when the men and leaders came back, the news of the struggle spread to the neighbouring Laata and other villages including Henwalghati, and additional number of people joined in. In the last, only after a four-day confrontation, the contractors left.
- After this incident, the then state Chief Minister, Hemwati Nandan Bahuguna, set up a commission to look into the matter. The commission ruled in favour of the villagers. This result became a defining moment in the history of environmental movements in India, and indeed, around the world.
- Silent Valley is situated in Palghat district in Kerala. It is of significant value since it contains the last critical stretch of tropical evergreen forest in India. In fact, its value comes from the fact that it is the only remnant of near virgin forest in the entire Western Ghats.
- The decision to build a dam on the Kunti River was initiated by the British government in pre-independence India. The Kunti river originates from the Silent Valley forest. Due to some reasons, the project was not implemented at that time. Post-independence, the first survey of the proposed hydroelectric project was conducted in 1951 by the state government. The project plan was later approved by the Planning Commission of India in 1973.

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- Understanding the importance of the valley, many teachers and Scientists joined hands to launch many protests against the proposed dam. Due to the protests, a stay was put on the project in 1976 by the National Committee on Planning and Coordination (NCEPC).
- The discussions and protests continued for quite a while and finally in 1983, the then Prime Minister Mrs. Indira Gandhi advised that the State government to cancel the project. She also named Silent Valley as a National Park. The National Park was opened in 1985.
- The Silent Valley Movement was the continuation of the development related issues which had just begun in India with the Chipko movement in the 1970s. The success of the movement presented another view of development which guarantees sustainability and protected the privileges of the non-human world.

12.7 KEY WORDS

- **Environmental movement:** It refers to 'as organized social activity consciously directed towards promoting sustainable use of natural resources, halting environmental degradation or bringing about environmental restoration.'
- **Chipko movement:** It refers to the series of movement in Uttarakhand regions in the early 1970s when the villagers in the region protested hugging trees to prevent them from being cut down.
- **Save silent valley movement:** It was a movement in the Silent valley of Kerala started in the 1973 against the construction of a hydro-electric power project in the region.

12.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Why did Guha and Baviskar did not want their studies to be considered as those of solely environmental movements in relation to Chipko and Narmada Bachao Andolan?
2. Mention some of the popular environmental movements in India.
3. When did the situation in Uttarakhand changed after India gained independence?
4. Write a short note on the involvement of women in the Chipko valley movement.
5. What is the uniqueness of the silent valley movement?

Long-Answer Questions

1. Explain how different researchers have classified environmental movements in India.
2. Describe the origin, course and conclusion of the Chipko movement in India.
3. Discuss the significance, manner and result of the Silent valley movement.

12.9 FURTHER READINGS

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UNIT 13 MAJOR ENVIRONMENT MOVEMENTS IN INDIA-II

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Structure

13.0 INTRODUCTION

Environmental movements in India have been aimed at conservation of the natural resources in the country. The movements have stressed on sustainable management of resources so that the state of the environment does not depreciate further. The Appiko Movement, similar to the Chipko movement, witnessed activists embracing the trees to prevent felling. This movement was extremely effective and it spread to other areas as well. The Narmada Valley Project, initiated in 1985, spurred another movement in India which took the shape of Narmada Bachao Andolan. Dalits, tribals and activists actively took part in the movement to register their protest against the Narmada Valley Project. Since the 1980s, various legislations have been introduced for environmental protection in India. The legislations will be discussed in detail in this unit.

13.1 OBJECTIVES

After going through this unit, you will be able to:

- Discuss in detail the Appiko Movement
- Examine the Narmada Valley Project and the resistance to the project
- Analyse the legislations relating to environmental protection

13.2 APPIKO MOVEMENT

In the early 1980s, the people's fight against commercial forest policy has become visible in the UttaraKannada region. The ecosystem of the forest had changed

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considerably due to the destruction of tropical natural forests. The access to biomass, fertilizers, etc. were impacted due to the destruction of mixed species. The forest department was trying to start monoculture of taek wood for businesses.

The felling of natural forests caused major soil erosion and dried up the sources of water. Stirred by the destruction of the environment, the youth of Salkani village in Sirsi started a Chipko movement. This movement was locally known as 'Appiko Chaluvali'. As part of the movement, the young people embraced the trees which were to be felled by the forest department.

The resistance against the contractors of the forest department which started in Bilegal forest in Hulekal range in september 1983 continued inside the forest for 38 days. Finally, the felling orders were taken back. This achievement causes the movement to spread to different areas; the movement was launched in eight regions covering entire Sirsi forest division in Uttara Kannada and Shimoga districts.

The Appiko Movement, which was similar to the Chipko Movement, was started in September 1983 by the representatives of a Yuvak Mandali to save the Western Ghats in Southwest India. It was seen by the representatives that there was an excessive concentration of trees reserved for felling in regions which were easily accessible. Also, there was excessive damage to other trees during the felling process.

In a one-hectare plot, it was discovered that 11 trees had been set apart for cutting, out of which 8 were cut. During the felling of these eight trees, at least five other older and healthy trees had been harmed. The devastation of forest resources was impacting the local community, who finally protested to stop the felling of trees through non-violent action as was seen in the case of Chipko movement.

There were three objectives of the Appiko Movement—to preserve the existing forest cover, to rejuvenate trees on bare lands, and to utilize forest wealth with respect to conservation. These objectives are implemented through the establishment of Parisara Samrakshna Kendras (environmental conservation centers).

The Appiko movement created awareness among people throughout the Western Ghats regarding the ecological devastation of forests. Because of this movement, people are now closely monitoring forest destruction and highlighted the divide between the proclaimed practices and actual practices with regards to forest management. The regional rainforests have been used for the plywood and paper industry; moreover, the conversion of forest to monoculture plantations and the building of large hydro-electric dams for power generation have also negatively impacted the livelihood of forest-dwellers.

The Appiko Movement compelled the public authority to make changes to its forest policy. Some of the changes were ban for clear felling, no further issuance of concessions to logging organizations, and ban on felling of green trees in the tropical rainforest of the Western Ghats.

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Check Your Progress

1. When did the Appiko Movement start?
2. What were some of the changes brought forth by the Appiko Movement?

13.3 PROTEST AGAINST NARMADA PROJECT

The Narmada Valley project or the Sardar Sarovar and Narmada Sagar Valley project has been facing stiff resistances from local people who are fighting against their displacement in the streets and also in the highest court of the land. The reasons for fighting against the project are obvious. The Narmada Valley project was a huge project initiated in 1985 intended to build 30 major, 135 medium and around 3000 small dams at various points of the river. The river is around 1300 km long and flows through three main states—Madhya Pradesh, Maharashtra and Gujarat, before it reaches the Gulf of Cambay in Arabian Sea. The project is aimed to serve three main purposes—provide irrigation to adjacent areas, produce electricity and provide drinking water along with other minor facilities like tourism. It should be noted that most areas of the Narmada Valley and states around it are dry regions. Farming is backward due to an absence of irrigation facilities. The region is dry and therefore potable water is a scarce resource. The projected electricity generation (around 3000 MW) from the project can increase the industrialisation of the region. However, it is also true that dams on Narmada are causing massive displacement of the people (around one million) and can also cause salinisation and water logging in the entire area. Siltation in the reservoirs due to soil erosion will reduce the economic use of the dams. Scientists also fear that the salinisation of the upper stream can cause more submergence of the land than it has been estimated. The dams will hamper the flow of river water and it is expected that fish species will also be badly affected. The water logging in the dam area may also result in malaria becoming pandemic. The project will also result in a massive loss of biodiversity as forests will be cleared for the construction of dams and for the resettlement of a million people.

The Narmada Bachao Andolan (NBA) is a grass-root movement that was formed to fight against the environmental, social and cultural damage that the Narmada Valley Developmental Project (NVDP) has caused. As mentioned earlier, the NVDP's proposal consists of 30 large dams, 135 medium dams, 3,000 small dams on the river Narmada and its over four tributaries; it threatens the life and livelihood of the 22 million inhabitants of the Narmada basin. The Sardar Sarovar Project (SSP), the largest dam, alone will submerge 245 villages,19 in Gujarat, 33 in Maharashtra and 193 in Madhya Pradesh. According to NBA, 250,000 people will be affected by the SSP.

The government sources claim that the SSP would irrigate more than 1.8 million hectares of land and solve the water crisis in the drought-prone areas of Kutch and Saurashtra. The NBA responds by saying that these are exaggerated figures and the actual benefits are much less than what is projected. The NBA also argued that in the whole process of the NVDP, the riparian rights of the people who live in the valley, including the tribals and peasants were not taken into consideration. In addition to this are the woes of those who have been displaced by the dam construction that has been resumed by the court order in the year 2000. The projected figure of 15,000 affected families in Maharashtra, though promised rehabilitation, is yet to materialize.

The NBA has taken up a lot of issues related to the riparian rights of the people. NBA is a politics that is a complex articulation of land rights, environmental degradation, economies of large dams and also the effects of these on the local communities. The fact that the process of development right from its origin, plan and management of resources is seen as a prerogative of the State is the basic point of opposition for the movement. The movement emphasizes that the people have the right to control their own forest, land, water and other natural resources. The movement thus is a deep-rooted critique of the development paradigm. NBA is committed to nonviolent means of protest and believes that nonviolence is the only path for a social movement.

NBA has relied heavily on the media to popularize their struggles and issues and the mainstream national media has been an important part of their campaigns. Leaders and activists of the movement often write in various newspapers and publications. NBA also communicates through frequent press releases giving the status of the struggle from time to time. The media is also informed about the several mass agitations and other programmes and activities.

For communicating with the people of the valley, the NBA depends on other forms of media like songs, leaflets, posters, audio cassettes, etc. Though the NBA and the NVDP have been discussed quite widely in national and regional newspapers and the visual media, many of the issues discussed earlier with environmental reporting are relevant here too. The media's interest in events rather than processes has seriously affected the NBA reporting in various ways. A movement like NBA, with its issues of displacement and the development paradigm that caused this, are equally important. But the media generally does not sustain its focus on long-term processes and gives space only when there are mass actions such as rallies or a dharna in the national capital. Of the 435 stories on the Sardar Sarovar Project in 2006, including those in English dailies, TV; periodicals and Internet news sites, more than 75 per cent of the stories are when devastating events like floods happen. The rest happen to be around mass actions like rallies and dharnas. The handful of well-researched writings is either specialist columns in newspapers or Internet news sites.

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The media often links issues and movements to the leaders and activists who are involved in them. One reason could be that these leaders are the ones who become the most visible while bringing to the notice of the world the needs and problems affecting the struggle. The media finds a face for the movement in Medha Patkar, making the NBA look like a single-handed task, whereas in reality, it is a multitiered movement, consisting of adivasis, Dalits, Hindu peasants and also various middle-class activists and supporters. The movement is influenced by both community and activists. The decision-making body has two main groups: the full-time activists as well as community representatives from every village. In terms of projecting the leaders, the media often makes movements seem like individual struggles. On the flip side, often protests and rallies that do not include the respective leaders are not given adequate coverage. For instance, on 17 December 2005, the police lathicharged hundreds of protestors in Badhwani, Madhya Pradesh outside the collector's office. This got little coverage, none in the mainstream national media. During the Satyagraha staged by NBA in April 2006, the event got covered extensively when film actor Aamir Khan visited the pandal to express his solidarity with the displaced people of the valley.

In the 1980s, voices were raised by the Narmada Bachao Andolan activists against the Sardar Sarovar dam construction on the Narmada River. This led to large-scale displacement of adivasis who were neither relocated to a proper area nor granted proper compensation. Besides, the dam was causing serious environmental hazards. Why did no political party take up the issue? Or, for example, in the 1980s itself, we saw women from various strata of the society raising their voices against violence perpetrated against them. Why did no political party take up the issues they raised or why did they just pay lip service to their cause?

Democracy is largely understood as popular sovereignty where people have control over the decisions made by the State. Since it is not practically possible for the people in the modern democratic societies to participate in the decision-making process of the State directly, they do so through representatives. This representation gets its institutional form in political parties and it is through political parties that the people wish to articulate and represent their demands. But when political parties become ineffective in representing the interests of the people, we see the emergence of social movements.

The movement has been protesting steadfastly against raising the height of the dam ever since its construction started in 1987 and which was not heeded to when the gates of the Sardar Sarovar Dam where opened in 2017. But there have been certain achievements which deserve credit like convincing the World Bank to withdraw its loan. Further the movement also forced backing in the construction of the project by companies like Siemens and Ogden Energy. The movement is still going on today thirty-five years after it first started fighting for the compensation and rehabilitation of the displaced people of Madhya Pradesh and Gujarat.

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Check Your Progress

3. Mention the three-fold objective of the Narmada Valley project.
4. How many dams are to be constructed as part of the Narmada Valley Developmental Project?

13.4 PROTECTIVE MEASURES

The need for insurance and preservation of the environment and the maintenance of natural resources is reflected in the established structure of India and furthermore in the global responsibilities of India. The Constitution under Part IVA (Art 51A-Fundamental Duties) obligates each resident of India to secure and improve the common habitat including forests, lakes, rivers and wildlife, and to have empathy for living animals. Further, the Constitution of India under Part IV (Art 48A-Directive Principles of State Policies) mentions that the State will try to secure and improve the environment and protect the forests of the country.

A few legislations regarding environment protection were put in place even before the Independence of India. Nonetheless, the genuine push for putting in place a system came after the UN Conference on the Human Environment (Stockholm, 1972). After the Stockholm Conference, the National Council for Environmental Policy and Planning was set up in 1972 inside the Department of Science and Technology to set up an administrative body to take care of the climate related issues. This Council later advanced into an undeniable Ministry of Environment and Forests (MoEF).

The MoEF was set up in 1985, which is the nodal agency in the administrative structure of the Central Government for planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes. The MoEF and the pollution control boards (CPCB, ie, Central Pollution Control Board and SPCBs, ie, State Pollution Control Boards) together structure the administrative and managerial centre of the segment.

The National Green Tribunal Act, 2010

The National Green Tribunal Act, 2010 (No. 19 of 2010) (NGT Act) has been enacted with the objective to provide for establishment of a National Green Tribunal (NGT) for the effective and expeditious disposal of cases relating to environment protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto.

The Act received the assent of the President of India on 2 June 2010, and was enforced by the Central Government vide Notification no. S.O. 2569(E)

dated 18 October 2010, with effect from 18 October 2010. The Act envisages establishment of NGT in order to deal with all environmental laws relating to air and water pollution, the Environment Protection Act, the Forest Conservation Act and the Biodiversity Act as have been set out in Schedule I of the NGT Act.

Consequent to enforcement of the National Green Tribunal Act, 2010, the National Environment Tribunal Act, 1995 and the National Environment Appellate Authority Act, 1997 stand repealed. The National Environment Appellate Authority established under s 3(1) of the National Environment Appellate Authority Act, 1997 stands dissolved, in view of the establishment of the National Green Tribunal under the National Green Tribunal Act, 2010 vide Notification no. S.O. 2570(E) dated 18 October 2010.

The Air (Prevention and Control of Pollution) Act, 1981

The Air (Prevention and Control of Pollution) Act, 1981 (the 'Air Act') is an act to provide for the prevention, control and abatement of air pollution and for the establishment of Boards at the Central and State levels with a view to carrying out the aforesaid purposes.

To counter the problems associated with air pollution, ambient air quality standards were established under the Air Act. The Air Act seeks to combat air pollution by prohibiting the use of polluting fuels and substances, as well as by regulating appliances that give rise to air pollution. The Air Act empowers the State Government, after consultation with the SPCBs, to declare any area or areas within the State as air pollution control area or areas. Under the Act, establishing or operating any industrial plant in the pollution control area requires consent from SPCBs. SPCBs are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes.

The Water (Prevention and Control of Pollution) Act, 1974

The Water Prevention and Control of Pollution Act, 1974 (the 'Water Act') has been enacted to provide for the prevention and control of water pollution and to maintain or restore wholesomeness of water in the country. It further provides for the establishment of Boards for the prevention and control of water pollution with a view to carry out the aforesaid purposes. The Water Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. At the Centre, the Water Act has set up the CPCB which lays down standards for the prevention and control of water pollution. At the State level, SPCBs function under the direction of the CPCB and the State Government.

Further, the Water (Prevention and Control of Pollution) Cess Act was enacted in 1977 to provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities. This cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted

under the Water (Prevention and Control of Pollution) Act, 1974. The Act was last amended in 2003.

The Environment Protection Act, 1986

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The Environment Protection Act, 1986 (the 'Environment Act') provides for the protection and improvement of environment. The Environment Protection Act establishes the framework for studying, planning and implementing long-term requirements of environmental safety and laying down a system of speedy and adequate response to situations threatening the environment. It is an umbrella legislation designed to provide a framework for the coordination of central and state authorities established under the Water Act, 1974 and the Air Act. The term 'environment' is understood in a very wide term under s 2(a) of the Environment Act. It includes water, air and land as well as the interrelationship which exists between water, air and land, and human beings, other living creatures, plants, micro-organisms and property.

Under the Environment Act, the Central Government is empowered to take measures necessary to protect and improve the quality of environment by setting standards for emissions and discharges of pollution in the atmosphere by any person carrying on an industry or activity; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time, the Central Government issues notifications under the Environment Act for the protection of ecologically-sensitive areas or issues guidelines for matters under the Environment Act.

In case of any non-compliance or contravention of the Environment Act, or of the rules or directions under the said Act, the violator will be punishable with imprisonment up to five years or with fine up to Rs 1,00,000, or with both. In case of continuation of such violation, an additional fine of up to Rs 5,000 for every day during which such failure or contravention continues after the conviction for the first such failure or contravention, will be levied. Further, if the violation continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years.

Hazardous Wastes Management Regulations

Hazardous waste means any waste which, by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics, causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances.

There are several legislations that directly or indirectly deal with hazardous waste management. The relevant legislations are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and rules and notifications under the Environmental Act. Some of the rules dealing with hazardous waste management are discussed below:

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Hazardous Wastes (Management, Handling and Transboundary) Rules, 2008, brought out a guide for manufacture, storage and import of hazardous chemicals and for management of hazardous wastes.

Biomedical Waste (Management and Handling) Rules, 1998, were formulated along parallel lines, for proper disposal, segregation, transport, etc. of infectious wastes.

Municipal Solid Wastes (Management and Handling) Rules, 2000, aim at enabling municipalities to dispose municipal solid waste in a scientific manner.

In view of the short-comings and overlapping of some categories causing inconvenience in implementation of the Biomedical Waste (Management and Handling) Rules, 1998 as well as the Municipal Solid Wastes (Management and Handling) Rules, 2000, the Ministry of Environment, Forest and Climate Change has formulated the draft Bio-Medical Waste (Management & Handling) Rules, 2015 (Draft BMW Rules) and the draft Solid Waste Management Rules, 2015 (Draft SWM Rules) and sought comments on the draft Rules.

The Draft BMW Rules are to replace the Biomedical Waste (Management and Handling) Rules, 1998, and the Draft SWM Rules are to replace the Municipal Solid Waste (Management and Handling) Rules, 2000. The objective of the Draft BMW Rules is to enable the prescribed authorities to implement the rules more effectively, thereby, reducing the bio- medical waste generation and also for its proper treatment and disposal and to ensure environmentally sound management of these wastes, and the Draft SWM Rules aim at dealing with the management of solid waste including it segregation at source, transportation of waste, treatment and final disposal.

E - Waste (Management and Handling) Rules, 2011 was notified on 1 May 2011 and came into effect from 1 May 2012, with primary objective to reduce the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous material and to channelize the e-waste generated in the country for environmentally sound recycling. The Rules apply to every producer, consumer or bulk consumer, collection centre, dismantler and recycler of e-waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components as detailed in the Rules.

Batteries (Management & Handling) Rules, 2001 deal with the proper and effective management and handling of lead acid batteries waste. The Act requires all manufacturers, assemblers, re-conditioners, importers, dealers, auctioneers, bulk consumers, consumers, involved in manufacture, processing, sale, purchase and use of batteries or components thereof, to comply with the provisions of Batteries (Management & Handling) Rules, 2001.

Other Laws Relating to Environment

In addition, there are many other laws relating to environment, namely–

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The Wildlife Protection Act, 1972

The Wildlife (Protection) Act, 1972 was enacted with the objective of effectively protecting the wildlife of this country and to control poaching, smuggling and illegal trade in wildlife and its derivatives. The Act was amended in January 2003 and punishment and penalty for offences under the Act have been made more stringent. The Ministry has proposed further amendments in the law by introducing more rigid measures to strengthen the Act. The objective is to provide protection to the listed endangered flora and fauna and ecologically important protected areas.

The Forest Conservation Act, 1980

The Forest Conservation Act, 1980 was enacted to help conserve the country's forests. It strictly restricts and regulates the de-reservation of forests or use of forest land for non-forest purposes without the prior approval of Central Government. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, recognises the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according the same.

The Indian Forest Act, 1927 consolidates the law relating to forests, the transit of forest-produce and the duty to be levied on timber and other forest-produce.

Public Liability Insurance Act, 1991

The Public Liability Insurance Act, 1991 was enacted with the objective to provide for damages to victims of an accident which occurs as a result of handling any hazardous substance. The Act applies to all owners associated with the production or handling of any hazardous chemicals.

The Biological Diversity Act, 2002

The Biological Diversity Act 2002 was born out of India's attempt to realise the objectives enshrined in the United Nations Convention on Biological Diversity (CBD), 1992 which recognises the sovereign rights of states to use their own Biological Resources. The Act aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner. The National Biodiversity Authority in Chennai has been established for the purposes of implementing the objectives of the Act.

Coastal Regulation Zone Notification

The Ministry of Environment and Forests had issued the Coastal Regulation Zone Notification vide Notification no. S O. 19(E), dated 6 January 2011 with an objective to ensure livelihood security to the fishing communities and other local communities living in the coastal areas, to conserve and protect coastal stretches and to promote development in a sustainable manner based on scientific principles,

taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming.

NOTES

Check Your Progress

5. In which year was the MoEF set up?
6. When was the Water Prevention and Control of Pollution Act, 1974 last amended?
7. What are some of the legislations that deal with hazardous waste management?
8. What is the aim of the Biological Diversity Act 2002?

13.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The Appiko Movement, which was similar to the Chipko Movement, was started in September 1983 by the representatives of a Yuvak Mandali to save the Western Ghats in Southwest India.
2. The Appiko Movement compelled the public authority to make changes to its forest policy. Some of the changes were ban for clear felling, no further issuance of concessions to logging organizations, and ban on felling of green trees in the tropical rainforest of the Western Ghats.
3. The Narmada Valley project is aimed to serve three main purposes—provide irrigation to adjacent areas, produce electricity and provide drinking water along with other minor facilities like tourism.
4. The NVDP's proposal consists of 30 large dams, 135 medium dams, 3,000 small dams on the river Narmada and its over four tributaries.
5. The MoEF was set up in 1985, which is the nodal agency in the administrative structure of the Central Government for planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes.
6. The Water Prevention and Control of Pollution Act, 1974 was last amended in 2003.
7. There are several legislations that directly or indirectly deal with hazardous waste management. The relevant legislations are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and rules and notifications under the Environmental Act.
8. The Biological Diversity Act 2002 aims at the conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner.

13.6 SUMMARY

NOTES

- The youth of Salkani village in Sirsi started a Chipko movement, stirred by the destruction of the environment. This movement was locally known as 'Appiko Chaluvali'. As part of the movement, the young people embraced the trees which were to be felled by the forest department. The resistance against the contractors of the forest department continued inside the forest for 38 days. Finally, the felling orders were taken back.
- The Appiko Movement, which was similar to the Chipko Movement, was started in September 1983 by the representatives of a Yuvak Mandali to save the Western Ghats in Southwest India.
- There were three objectives of the Appiko Movement—to preserve the existing forest cover, to rejuvenate trees on bare lands, and to utilize forest wealth with respect to conservation. These objectives are implemented through the establishment of Parisara Samrakshna Kendras (environmental conservation centers).
- The Appiko Movement compelled the public authority to make changes to its forest policy. Some of the changes were ban for clear felling, no further issuance of concessions to logging organizations, and ban on felling of green trees in the tropical rainforest of the Western Ghats.
- The Narmada Valley project was a huge project initiated in 1985 intended to build 30 major, 135 medium and around 3000 small dams at various points of the river. The river is around 1300 km long and flows through three main states—Madhya Pradesh, Maharashtra and Gujarat, before it reaches the Gulf of Cambay in Arabian Sea.
- The Narmada Valley project is aimed to serve three main purposes—provide irrigation to adjacent areas, produce electricity and provide drinking water along with other minor facilities like tourism.
- The dams on Narmada are causing massive displacement of the people (around one million) and can also cause salinisation and water logging in the entire area. Siltation in the reservoirs due to soil erosion will reduce the economic use of the dams. Scientists also fear that the salinisation of the upper stream can cause more submergence of the land than it has been estimated.
- The Narmada Bachao Andolan (NBA) is a grass-root movement that was formed to fight against the environmental, social and cultural damage that the Narmada Valley Developmental Project (NVDP) has caused.
- In the 1980s, voices were raised by the Narmada Bachao Andolan activists against the Sardar Sarovar dam construction on the Narmada River. This led to large-scale displacement of adivasis who were neither relocated to a proper area nor granted proper compensation.

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- The Constitution under Part IVA (Art 51A-Fundamental Duties) obligates each resident of India to secure and improve the common habitat including forests, lakes, rivers and wildlife, and to have empathy for living animals. Further, the Constitution of India under Part IV (Art 48A-Directive Principles of State Policies) mentions that the State will try to secure and improve the environment and protect the forests of the country.
- The Ministry of Environment and Forests (MoEF) was set up in 1985, which is the nodal agency in the administrative structure of the Central Government for planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes.
- The National Green Tribunal Act, 2010 (No. 19 of 2010) (NGT Act) has been enacted with the objective to provide for establishment of a National Green Tribunal (NGT) for the effective and expeditious disposal of cases relating to environment protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto.
- The Air (Prevention and Control of Pollution) Act, 1981 (the 'Air Act') is an act to provide for the prevention, control and abatement of air pollution and for the establishment of Boards at the Central and State levels with a view to carrying out the aforesaid purposes.
- The Water Prevention and Control of Pollution Act, 1974 (the 'Water Act') has been enacted to provide for the prevention and control of water pollution and to maintain or restore wholesomeness of water in the country. It further provides for the establishment of Boards for the prevention and control of water pollution.
- The Environment Protection Act, 1986 (the 'Environment Act') provides for the protection and improvement of environment. The Environment Protection Act establishes the framework for studying, planning and implementing long-term requirements of environmental safety and laying down a system of speedy and adequate response to situations threatening the environment.
- There are several legislations that directly or indirectly deal with hazardous waste management. The relevant legislations are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and rules and notifications under the Environmental Act.
- There are many other laws relating to environment, namely, the Wildlife (Protection) Act, 1972, the Forest Conservation Act, 1980, the Public Liability Insurance Act, 1991, the Biological Diversity Act 2002, etc.

13.7 KEY WORDS

NOTES

- **Salinization:** It is the process by which water-soluble salts accumulate in the soil. It is a concern as excess salts hinder the growth of crops by limiting their ability to absorb water.
- **Siltation:** It is a process by which water becomes dirty as a result of fine mineral particles in the water
- **Biodiversity:** It is a term used to describe the enormous variety of life on Earth.
- **Hazardous waste:** It means any waste which, by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics, causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances.
- **Poaching:** It is the illegal hunting or capturing of wild animals.

13.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Write a short note on the Appiko Movement.
2. How have the Narmada Valley Project negatively impacted the lives of the people?
3. Briefly mention the objectives of the Air (Prevention and Control of Pollution) Act, 1981.
4. Write a short note on the Wildlife (Protection) Act, 1972.

Long-Answer Questions

1. Discuss in detail the Narmada Valley Project.
2. Examine the resistance to the Narmada Valley Project.
3. Discuss the key legislations introduced by the Indian government to ensure environmental protection.

13.9 FURTHER READINGS

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UNIT 14 GOVERNMENT LEGISLATIONS, NGOs AND ENVIRONMENTAL ACTIVITIES

Structure

14.0 INTRODUCTION

In the previous unit, you learnt about environmental movements in India such as the Appiko movement and the Narmada Bachao Andolan. In this unit, which is the final unit of the book, you will learn about Government legislations passed in India to protect the environment. For the holistic development of a nation like India, environment protection and economic growth must go hand in hand. There are some areas which are covered in their entirety by Indian laws specific to them like the comprehensive Environment Protection Act, but there are some areas related to environment protection where the rules are not exhaustive or present under a single umbrella, such as rules related to safe disposal of waste and other effluents. Besides, only the presence of a law to protect environmental good is not enough, there is a need to have a sound monitoring and enforcement framework so that checks can be made and penalties laid on the polluters. The unit will also discuss the role of NGOs in environment protection, judicial rulings for environmental protection, as well as environmental activities.

14.1 OBJECTIVES

After going through this unit, you will be able to:

- Explain the various environmental laws in India which come under the common laws
- Assess the different land laws pertaining to environment protection
- Discuss some court rulings in India related to environment protection
- Explain the role played by NGOs in environment protection

14.2 GOVERNMENT LEGISLATIONS

There are several different kinds of environmental laws in the country. These can be classified on the basis of their overall purview. In this section, you will study about common laws, land laws and some specific environmental laws and notifications. Bear in mind, all of these legislations were introduced to you in Unit 13 under protective measures and these will be discussed in this section in detail.

14.2.1 Common and Criminal Laws

Environmental laws are the laws for protecting soil, air, water, the oceans and biodiversity, as well as laws which protect the environment as a whole. They can protect areas of land or ocean and individual species. They necessitate the conducting of environmental impact assessment (EIA) before any activity gets the approval of the enforcing agencies. They may also require people to remedy any environmental damage they cause. Environmental laws come under both common laws and criminal laws.

Common laws are the laws developed by the courts over many years. There are a number of common law principles which are relevant to protecting the environment, especially for the issues involving a dispute between neighbours. A criminal law states that to do something is an ‘offence’ and imposes a fine or custodial sentence on an offender. An example of a criminal environmental law is that it is an offence for any person to cause pollution or allow it to be caused. Criminal laws can be enforced by prosecution, which means the person who is alleged to have committed the offence is formally charged and required to attend court.

Laws such as the Environmental Protection Act, 1986, the Air (Prevention and Control of Pollution) Act, 1981, and the Water (Prevention and Control of Pollution) Act, 1974, are discussed in this section.

(1) The Environmental (Protection) Act, 1986

The objective of this act is to provide for the protection and improvement of environment and for matters connected there with. This protection and improvement

of environment in turn protects human beings, other living creatures, plants and property from hazards.

As per this Act, the central government is empowered to take all such measures as it deems necessary for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution.

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- **Main provisions**

1. No person carrying on any industry, operation or process shall discharge or emit or permit to be discharged or emitted any environmental pollutants in excess of such standards as may be prescribed.
2. No person shall handle any hazardous substance except in accordance with such procedure and after complying with such safeguards as may be prescribed.
3. The person responsible for discharge of any environmental pollutant in excess of the prescribed standards is bound to prevent or mitigate the environmental pollution caused and shall also forthwith intimate the fact of such occurrence or apprehension of such occurrence to the authorities concerned. The person is also bound to assist the authorities in attending to the work if he is required to do so.

- **Environmental laboratories**

As per Section 12 of the Act, the central government can establish one or more environmental laboratories or recognize one or more laboratories or institutes as environmental laboratories to carry out the functions entrusted. The central government may also make rules for the functions and procedures to be followed by such laboratories. Taking samples of air, water, soil or other substances for analysis and the form of the laboratories reports and the fees payable for such report, etc., will be chalked out by the central government.

- **Penalty for contravention of the provisions**

Whoever fails to comply with or contravenes any of the provisions of this Act or rules shall in respect of each failure or contravention, be imprisoned for a term which may extend to five years or be fined which may extend to one lakh rupees or both. In case the failure or contravention continues, an additional fine of five thousand rupees per day is also liable.

- **Offences by companies**

Where any offence under this Act has been committed by a company, every person who, at the time of the offence was committed was directly in charge of, and was responsible to the company for the conduct of the business of the company shall be deemed to be guilty of the offence and shall be liable to be prosecuted against and punished.

• **Protection of action taken in good faith**

Section 18 of this Act states that no suit, prosecution or other legal proceeding shall lie against the government or any officer or any other employee of the government in respect of anything which is done or intended to be done in good faith in pursuance of this Act or the rules.

• **Cognizance of offences**

No court shall take cognizance of any offence under this Act except on a complaint made by:

(a) The central government or any authority or officer authorized on its behalf by the government or

(b) Any person who has given notice of not less than sixty days, in the manner prescribed, of the alleged offence and of his intention to make a complaint, to the central government or the authority or officer authorized as aforesaid.

(2) The Water (Prevention and Control of Pollution) Act, 1974

Following are the aims of Water (Prevention and Control of Pollution) Act, 1974:

(i) To provide for the prevention and control of water pollution

(ii) To maintain or restore the wholesomeness of water

(iii) To establish water pollution control boards for the prevention and control of water pollution

(iv) To assign suitable powers and functions for the water pollution control boards

• **Central and state boards**

This Act empowers the constitution of Central and State boards to exercise the powers conferred and perform the functions assigned to the respective boards under this Act.

(a) Powers and functions of boards

The main function of the Central Board is to promote cleanliness of streams and wells in different areas of states. The other miscellaneous functions are as follows:

1. To advise the central government on any matter concerning the prevention and control of water pollution
2. To coordinate the activities of the state boards and resolve disputes among them
3. To provide technical assistance and guidance to the State Boards, carryout and sponsor investigations and research relating to problems of water pollution
4. To plan and organize the training of persons engaged or to be engaged in programmes for the prevention, control or statement or water pollution on such terms and conditions as the Central Board may specify

5. To organize through mass media a comprehensive programme regarding the preventions and control of water pollution
6. To collect, compile and publish technical and statistical data relating to water pollution and the measures devised for its effective prevention and control and prepare manuals, codes or guides relating to the treatment and disposal of sewage and trade effluents and disseminate information connected there with
7. To lay down, modify or annul in consultation with the state government concerned, the standards for a stream or well
8. To plan and cause to be executed a nation-wide programme for the prevention, control or abatement of water pollution
9. To perform such other functions as may be prescribed

(b) Important provisions of the act

Section 21: This section empowers the nominated officials of State Board to take samples of water from any stream or well or samples of any sewage or trade effluent which is passing from any plant or vessel (for the purpose of analysis). Such samples will be collected after due notice is given to the occupier of the area in question.

Section 22: The samples collected as referred above will be analysed by the nominated official of a recognized laboratory and he will submit a report of the results of such analysis. One copy of the report will be sent to the occupier and another copy will be preserved for production before the court in case any legal proceedings are taken against the occupier.

Section 23: This section empowers the nominated person of the Board to enter any place for the purpose of performing any of the functions of the Board entrusted to him. He is also empowered to examine any plant, record, register, document or any other material object or for conducting a search of any place in which he has reason to believe that an offence under this Act or the rules is suspected.

Section 24: This section deals with the prohibition on the use of stream or well for disposal of polluting matter, etc. It lays down that: 'No poisonous, noxious or polluting matter determined (as per the standards laid down by the State Board) should be permitted to enter any stream or will or sewer or on land.'

Section 25: As per this section, 'No person shall without the previous consent of the State Board:

(i) Can establish or take any steps to establish any industry, operation or process or any treatment and disposal systems or any extension or addition there to which is likely to discharge sewage or trade effluent into a stream or well or sewer or on land

(ii) Bring into use any new or altered outlet for the discharge of sewages or

(iii) Begin to make any new discharge of sewage

Section 26: According to this section, before the commencement of this Act, the person who was discharging any sewage or trade effluent into a stream or well or sewer or on land has to follow the rules of Section 25 mentioned above from a specific date as proposed by the state government.

Sections 32 and 33: In these sections, the provision relating to the accidental or unforeseen discharge of polluted, poisonous or noxious matter into the stream or well is dealt with. If such an accident or event takes place due to industrial operation or system, then the person in charge of such place has to inform the State Board about the occurrence of such accident or event. The State Board after assessing the extent of such polluted discharge into the stream or well can instruct the person to stop discharging the polluted matter. If necessary, the Board can approach the local court in the matter for getting a judgement.

(c) Penalties and procedure

Failure to comply with the directions referred in the above sections (32 and 33) can result in the person's conviction and resultant punishment with imprisonment for a term of three months with or without fine to the extent of ten thousand rupees. If the failure continues, a fine of rupees five thousand for every day can also be levied. If the failure continues beyond a one year period, then the person is liable for imprisonment of two to seven years period with fine.

(3) Air (Prevention and Control of Pollution) Act, 1981

Following are the aims of the Air (Prevention and Control of Pollution) Act, 1981:

(a) To provide for the prevention and control of air pollution

(b) To establish air pollution control boards for carrying out prevention and control of air pollution.

(c) To assign functions and confer powers on the boards after establishment

- **Central and state boards**

Central Pollution Control Board constituted under Section 3 of Water (Prevention and Control of Pollution) Act, 1974 shall have the powers and perform the functions of the Central Pollution Control Board for the prevention and control of air pollution under this Act. State Pollution Control Boards constituted under Section 4 of Water (Pollution and Control of Pollution) Act, 1974 will also be functioning as state boards under this Act.

The members of Central and State Boards for the Water (Prevention and Control of Pollution) Act will be the same for the Air (Pollution and Control Pollution) Act. The frequency of board meetings will also be the same (once in 3 months or earlier).

Restrictions regarding certain industrial plants

The state government, after consulting the State Board can prohibit the following aspects in the specified pollution control areas:

(a) The use of any fuel (other than approved fuel) which is likely to cause air pollution.

(b) No appliance other than an approved appliance can be used in the premises situated in an air pollution control area.

(c) Burning of any material (not being fuel) in any air pollution control area is prohibited since the same may cause air pollution.

- **Power of entry and inspection**

Any person empowered by a State Board shall have a right to enter at all reasonable times with required assistance as he considers necessary.

- **Power to obtain information**

For the purpose of carrying out the functions entrusted to it, the State Board or any office empowered by it can call for any information (pertaining to the types of air pollutants) from the occupier of any industry or industrial plant/control equipment for the purpose of verifying the correctness of such information. The officer of State Board can inspect the premises where he finds it necessary.

- **Power to take samples of air or emission**

Any State Board or any officer empowered by it will have the power to take samples of air or emission from any chimney, flue or duct or any other outlet for the purpose of analysis.

The person taking the samples will issue notice to the occupier (of the place/plant) stating his intention of carrying out analysis of air. The sample of air will be collected in the presence of the occupier or his representative. The collected air sample will be placed in a container (or containers) which then will be marked and sealed. Signatures of both the person taking the sample and the occupier or his agent will be affixed on the samples collected. The containers with the collected samples of air will then be sent to the laboratory established or recognized by the State Board.

- **Penalties and procedure**

Failure to carry out the directions of State Board will bring about the following penalties on the occupier or the person concerned.

In respect of each failure (for example, establishing a plant in the pollution control area) the occupier is punishable with imprisonment for a term which shall not be less than one year and six months, which may extend to six years and with fine. And in case failure continues, an additional fine may be levied which may extend to five thousand rupees for every day during which such failure continues after the conviction for the first such failure.

If the failure referred above continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term

which shall not be less than two years but which may extend to seven years and with fine.

- **Penalties for certain acts**

The following acts are punishable:

(a) Destroying, pulling down, removing, injuring or defacing any pillar, post or stake fixed in the ground or any notice or other matter put up, inscribed or placed, by the State Board.

(b) Obstructing any person acting under the orders or directions of the Board from exercising his powers and performing his functions under this Act.

(c) Damaging any works or property belonging to the board.

(d) Failing to furnish to the Board or any officer or any other employee of the board any information required by the Board or such officer or other employee for the purpose of this Act.

(e) Failing to intimate the occurrence of the emission of air pollutants into the atmosphere in excess of the standards laid down by the State Board.

(f) Furnishing false statement for getting consent for the establishment of his need.

All the above acts are punishable with imprisonment for a term which extends to three months or with fine which may extend to ten thousand rupees or with both.

14.2.2 Land Laws

Various acts and legislations, such as the Forest Protection Act, the Wildlife Protection Act, the Biodiversity Act and the SEZ Act, are intended to protect the land and minority communities.

(1) Forest Protection Act, 1927

The first Forest Act was enacted in 1927 and this is one of the many surviving colonial legislations. It was enacted to strengthen the law related to forests, the transit of the forest produce and the duty liable on timber and other forest produce.

Subsequently, the Forest (Conservation) Act was promulgated in 1980 to make certain reforms over the proceeding Act of 1927. This act deals with the four categories of forests, namely reserve forests, village forests, protected forests and private forests. A state may declare forest lands or wastelands as reserved forest and may sell the produce from these forests. Any unauthorized felling of trees, quarrying, grazing and hunting in reserved forests is punishable with a fine or imprisonment or both. The reserved forest assigned to a village community is called village forest. The state governments are empowered to designate protected forest and may prohibit the felling of trees, quarrying and the removal of the forest produce from such a forest. The preservation of protected forests are enforced

through rules, licenses and criminal prosecutions. Forest officers and their staff administer the Forest Act.

(2) Scheduled Tribes and Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

This Act is an outcome of the struggle by the marginal and tribal communities of our nation to assert their rights over forestland over whom they were conventionally dependent. This Act is essential to the rights of millions of tribal and other forest dwellers in different parts of our country as it provides for the compensation of underprivileged forest rights across India, as well as both individual rights to cultivated land in forestland and community rights over common property resources. The January 2008 notification of the rules for the execution of Forest Rights Act, 2006 has lastly paved the way to undo the 'historic injustice' done to the tribal community and other forest dwellers. With the help of this Act, the life of around 100 million poorest of the poor tribes stands to improve if its implementation is taken seriously. The Act is important because it provides scope and historic opportunity of protecting the basic rights of these poor people.

This Act is a potential tool:

- To make powerful as well as strengthen the local self-governance
- To deal with the living security of people, leading to poverty mitigation and pro-poor development
- To deal with the problems of conservation and management of the natural resources

Certain rights are given in Section 3(1) of the Act. These may be summarized as:

- Title rights related to the ownership of the land which is being farmed by the tribals or forest dwellers as on 13 December 2005, subject to a maximum of 4 hectares; this ownership is only for land which is really being cultivated by the concerned family as on that date, and that no fresh lands are approved
- The rights to use minor forest produce (including ownership also), grazing areas, pastoralist routes, etc.
- Relief and development rights such as rehabilitation when illegal eviction or forced displacement has happened and of necessary facilities, subject to limitations for forest protection
- Forest management rights to preserve forests and wildlife

(3) Wildlife Protection Act, 1972

According to the Wildlife Protection Act, 1972, the expression 'wildlife' includes any animal, bees, butterflies, fish and moths, and aquatic or land vegetation which forms a part of any habitat.

The Wildlife Protection Act was passed by the Indian Parliament in 1972 to protect India's wildlife. However, even during the period after the Act came into

force, the number of wild animals is going down alarmingly despite of the government efforts to protect them. With the increase in population, there is greater pressure on land. Forests are being destroyed as human habitation expands, thereby shrinking the wildlife habitats. There is also the clandestine international trade in wildlife and wildlife products which is a major cause for their wanton destruction. Meanwhile, the growing consumer society and the increasing emphasis on luxury and vanity items have also caused the exploitation of wildlife in the name of industrial progress.

(4) Coastal Regulation Zone Notification 2011

The Ministry of Environment and Forests (MoEF), Government of India issued its Notification S.O. 19 (E) dated 6 January 2011 on Coastal Regulation Zone (CRZ) replacing the earlier CRZ notification S.O. 114(E), dated 19 February 1991. Highlights of the notification are given below:

(a) Objectives

- Conserve and protect coastal stretches, its unique environment and its marine area
- Ensure livelihood security to fishermen/other communities living in the coastal areas
- Restrict the setting /storage/ disposal of hazardous substances in the CRZ areas

(b) CRZ Areas

These include coastal stretches of the country and the water area up to its territorial water limits (12 Nautical Miles), except the islands of Andaman and Nicobar and Lakshadweep, which are covered under a separate notification.

Classification of the CRZ:

1. CRZ-I: (Ecologically sensitive areas)
2. CRZ-II: (Built-Up-Areas)
3. CRZ-III: (Rural Areas)
4. CRZ-IV: (Water Areas)

(c) Regulation of permissible activities

- Clearance shall be given for any activity within the CRZ only if it requires waterfront and foreshore facilities for listed projects under this notification.
- Activities not listed in the EIA notification, 2006; construction activities relating to projects of Department of Atomic Energy or Defence requirements for which oreshore facilities are essential; construction, operation of lighthouses; laying of pipelines, conveying systems, transmission line.

Following procedure for clearance of permissible activities will be applicable to projects attracting this notification:

(i) Project proponents to apply with the following documents seeking prior clearance to the concerned State or the union territory Coastal Zone Management Authority (CZMA).

(ii) Concerned CZMA to examine the above documents and make recommendations within a period of sixty days from date of receipt of complete application.

(iii) MoEF or State Environmental Impact Assessment Authority (SEIAA) shall consider such projects for clearance based on the recommendations of the concerned CZMA within a period of sixty days.

(iv) The clearance accorded to the projects under the CRZ notification shall be valid for the period of five years from the date of issue of the clearance for the commencement of construction and operation.

(v) For post clearance monitoring:

- Project proponent to submit half-yearly compliance reports to the regulatory authority(s) concerned, on 1 June and 31 December of each calendar year. All such compliance reports by the project proponent to be published in public domain and its copies shall be given to any person on application to the concerned CZMA.
- The compliance report also to be displayed on the website of the concerned regulatory authority.

(vi) To maintain transparency in the working of the CZMA, it shall be the responsibility of the CZMA to create a dedicated website and post the agenda, minutes, decisions taken, clearance letters, violations, action taken on the violations and court matters including the orders of the Hon'ble Court as also the approved CZMA of the respective State Government or Union territory.

(d) Preparation of coastal zone management plans (CZMA)

The CZMA may be prepared by the State Government or Union territory by engaging reputed and experienced scientific institution(s) or the agencies including the National Centre for Sustainable Coastal Management (NCSCM) of MoEF and in consultation with the concerned stakeholders. The notification provides detailed procedure for the preparation of CZMA.

Enforcement of the Notification, 2011:

(i) For the purpose of implementation and enforcement of the provisions this notification and compliance with conditions stipulated thereunder, the powers either original or delegated are available under Environment (Protection) Act, 1986 with the MoEF, State Government or the Union Territory Administration NCZMA and SCZMAs.

(ii) The State Government or the Union Territory CZMAs shall primarily be responsible for enforcing and monitoring of this notification. To assist in this

task, the State Government and the Union Territory shall constitute district-level Committees under the Chairmanship of the District Magistrate concerned containing at least three representatives of local traditional coastal communities including the fisher-folks.

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(5) Biodiversity Act, 2002

The Biodiversity Act, 2002 aims to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources. The Act provides for the constitution of a National Biodiversity Authority at the national level, State Biodiversity Boards at the state levels and Biodiversity Management Committees at the local levels to implement the provisions of this Act.

India's richness in biological resources and indigenous knowledge relating to them is well recognized. One of the major challenges is in adopting an instrument which helps realize the objectives of equitable benefit sharing enshrined in the convention. Towards this end, the legislation on biodiversity was developed following an extensive consultative process. The legislation aims at regulating access to biological resources so as to ensure equitable sharing of benefits arising from their use. The Biological Diversity Bill, which was introduced in the Parliament on 15 May 2000, was referred to the Parliamentary Standing Committee for Science, Technology, and Environment and Forests for examination and evaluation.

(a) Salient features of the biodiversity legislation

The main intent of this legislation is to protect India's rich biodiversity and associated knowledge against their use by foreign individuals and organizations without sharing the benefits arising out of such use, and check biopiracy. The Act provides for setting up of a National Biodiversity Authority (NBA), State Biodiversity Board (SBB) and Biodiversity Management Committees (BMCs) in local bodies. The NBA and SBB are required to consult the BMCs in decisions relating to the use of biological resources/related knowledge within their jurisdiction and BMCs are to promote conservation, sustainable use and documentation of biodiversity.

All foreign national organizations require prior approval of the NBA for obtaining biological resources and/or associated knowledge for any use. Indian individuals/entities require approval from the NBA for transferring results of research with respect to any biological resources to foreign nationals/organizations. Collaborative research projects and exchange of knowledge and resources under these projects are exempted provided they are drawn as per policy guidelines of the Central Government and have its approval regarding the objectives of conservations, sustainable use and benefits sharing. However, Indian citizens/entities/ local people including vaids and hakims have free access to use biological resources within the country for their own use, medicinal purposes and research purposes.

(6) Environmental Impact Assessment Notification, 2006

In 1994, the Ministry of Environment and Forests (MoEF) issued a notification making Prior Environmental Clearance (PEC) mandatory for select categories of developmental and industrial projects. Subsequently, a number of amendments were brought out. However, the process of obtaining environmental clearance was perceived to be cumbersome and the inordinate delay in granting clearances has been a major cause of concern. The MoEF, therefore, embarked upon to revise or re-engineer the environmental clearance process. The Final Notification was published on 14 September 2006.

Highlights of the Notification

- **Authorities/committees**
  - o For all States and Union Territories, State Level Environment Impact Assessment Authority (SEIAA) shall be constituted by the Central Government comprising of a Chairman and a member Secretary in consultation with the State Government or the Union Territory Administration concerned. The non-official member and the Chairman shall have a fixed term of three years. All decisions of the SEIAA shall be unanimous and taken in a meeting. The SEIAA shall base its decision on the recommendations of a State or Union territory level Expert Appraisal Committee (SEAC).
  - o At the Central Government level, the MoEF shall be Environment Impact Assessment Authority (EIAA). The MoEF shall recommend environmental clearance based on the recommendations of an Expert Appraisal Committee (EAC).
  - o The composition of EAC and SEACs shall be as given in Appendix VI of the Notification. The EAC and SEACs shall function on the principle of collective responsibility. The EAC and SEAC shall meet at least once every month. The EAC and SEACs shall be reconstituted every three year.
- **Projects/activities requiring environmental clearance**

  All new projects or activities and/or expansion and modernization of the existing project or activities or any change in product-mix in an existing manufacturing unit included in the Schedule of the Notification shall require Prior Environmental Clearance (PEC) from MoEF for matters falling under Category 'A' and from SEIAA for matters falling under Category 'B' before any construction work.
  - o Mining, primary processing, material production, manufacturing/ fabrication, industrial estates/parks/complexes/areas (EPZ SEZ), common effluent treatment plans, common biomedical treatment facilities, common municipal solid waste facilities and isolated storages and handling

of hazardous chemicals, new construction projects and township projects are included in the Schedule.

- o Any project or activity specified in Category 'B' in the Schedule will be treated as Category 'A', if located in whole or in part within 10 km from the boundary of (i) Protected areas as notified under the Wildlife (Protection) Act 1972, (ii) Critically polluted areas as notified by the Central Pollution Control Board from time to time, (iii) Notified eco-sensitive areas, and (iv) Inter-state boundaries and international boundaries.

- **Validity/transferability of environmental clearance**

  The prior environmental clearance granted shall be valid for a period of ten years in the case of river valley projects, maximum of thirty years for mining projects and five years in the case of all other projects and activities.

Check Your Progress

1. What is implied by the phrase 'enforced by prosecution'?
2. In which year was the first Forest Act enacted in India?
3. Which act is the result of the struggle of marginal and tribal communities to assert their rights over forest produce?
4. As per the Wildlife Protection Act 1972, what constitutes the term 'wildlife'?

14.3 COURT DECISIONS

Indian heritage and culture has an intimate relation with the conservation and protection of the environment. The Indian State has also enshrined it in the Constitution which requires both the State and the Citizen to "protect and improve the environment". The Environment Act, 1986, as discussed in the previous section is one of those acts which extends to the whole of India without any exception.

Constitutional Interpretation of Environment

The 42nd Amendment to the Constitution of India added Article 48A and 51A(g) which comes under the Directive Principle of State Policy and the Fundamental Duties respectively. The Supreme Court of India in "*Sachidanand Pandey v. State of West Bengal AIR 1987 SC 1109*" stated that the Court is bound to bear in mind the above said articles whenever a case related to Environmental problem is brought to the Court.

The Article 48A states: "The State shall endeavour to protect and improve the environment and to safeguard the forest and wildlife of the country."

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The Article 51A(g) imposes a duty upon every citizen of India to protect and improve the natural environment and confers right to come before the Court for appropriate relief.

The Apex Court in "*DamodarRao v. S.O. Municipal Corporation AIR 1987 AP 171*" held that the environmental pollution and spoliation which is slowly poisoning and polluting the atmosphere should also be regarded as amounting to violation of Article 21 of the Indian Constitution.

Public Liability and Public Nuisance

"*M.C. Mehta and Anr. Etc vs. Union of India and Ors. Etc 1986 SCR (1) 312*" discusses the concept of Public Liability. This case is also known as Oleum Leakage Case. It is a landmark judgment in which the principle of Absolute Liability was laid down by the Supreme Court of India. The Court held that the permission for carrying out any hazardous industry very close to the human habitation could not be given and the industry was relocated.

The instant case evolved the "Deep Pocket Principle". This judgment guided the Parliament to add a new chapter to the Factory Act, 1948. The Public Liability Act was passed and the policy for the Abatement of Pollution Control was also established.

When the Directive Principles of State Policy has clear statutory expressions then the Court will not allow Municipal Government to make fun of the Statutes by sitting idly. It was decided by the Supreme Court in the "*Municipal Corporation, Ratlam vs. Vardhichand AIR 1980 SC 1622*". The plea of lack of fund will be poor alibi when people in misery cry for justice. The office in charge and even the elected representatives will have to face a penalty if they violate the constitutional and other statutory directives.

Sustainable Development

The Bench of Justices PN Bhagwati and Ranganath Mishra in "*Rural Litigation and Entitlement Kendra, Dehradun vs. State of Uttar Pradesh AIR 1987 SC 2187*" introduced the concept of sustainable development. An NGO named RLEK filed a case against limestone quarrying in the valley in 1987.

It was stated that the permanent assets of mankind are not to be exhausted in one generation. The natural resources should be used with requisite attention and care so that ecology and environment may not be affected in any serious way.

Environmental Impact Assessment

Justice Jeevan Reddy in the landmark judgment of "*Indian Council for Enviro-Legal Action vs. Union of India AIR 1999 SC 1502*" held that the financial costs of preventing or remedying damage caused by pollution should lie with the undertakings which cause the pollution by adopting the "Polluter Pays Principle".

The Court set a time limit for the coastal states to formulate coastal management plans and banned industrial or construction activity within 500 metres of the High Tide Line.

Water Pollution

The writ petition filed by the activist advocate M.C. Mehta in the Supreme Court highlighted the pollution of the Ganga River by the hazardous industries located on its banks. Justice ES Venkataramiah gave a historic judgement in "*M.C. Mehta vs. Union of India AIR 1988 SCR (2) 538*" ordering the closure of a number of polluting tanneries near Kanpur.

In this judgment it was observed that just like an industry which cannot pay minimum wages to its workers cannot be allowed to exist, a tannery which cannot setup a primary treatment plant cannot be permitted to continue to be in existence.

Air Pollution

The pride of India and one of the wonders of the world i.e., the Taj Mahal, was facing threat due to high toxic emissions from Mathura Refineries, Iron Foundries, Glass and other chemical industries. The acid rain was a serious threat to the Ta j Mahal and 255 other historic monuments within the Taj Trapezium.

The Apex Court in "*M.C. Mehta vs. Union of India (Taj Trapezium Case) AIR 1987*" delivered its historic judgment in 1996 giving various directions including banning the use of coal and cake and directing the industries to Compressed Natural Gas (CNG).

Environmental Awareness and Education Case

The Supreme Court in "*M.C. Mehta vs. Union of India WP 860/1991*" ordered the cinema theatres all over the country to exhibit two slides free of cost on environment in each show. Their licenses will be cancelled if they fail to do so. The Television network in the country will give 5 to 7 minutes to televise programmes on environment apart from giving a regular weekly programme on environment.

Environment has become a compulsory subject up to 12th standard from academic session 1992 and University Grants Commission will also introduce this subject in higher classes in different Universities.

Wildlife and Forest Protection Case

The livelihood of forest dwellers in the Nilgiri region of Tamil Nadu was affected by the destruction of forests. The Supreme Court in "*TN Godavarman Thirumulpad vs. Union of India and Ors*." passed a series of directions since 1995, till the final judgment in 2014.

The Apex Court decided to set up a Compensatory Afforestation Funds Management and Planning Authority (CAMPA) to monitor the afforestation efforts,

to oversee the compensation who suffered on account of deforestation, and to accelerate activities for preservation of natural forests.

A writ petition was filed by the Tarun Bharat Sangh in the Supreme Court to stop mining activities in the Sariska Wildlife Sanctuary. The Court in the case of "*The Tarun Bharat Sangh vs. Union of India and Ors. (1991)*" banned all the mining activities in the sanctuary.

Public Trust and Right to Life

The Bench of Justices Kuldip Singh and Sagir Ahmed held that the Government violated the Doctrine of Public Trust in "*M.C. Mehta vs. Kamal Nath and Ors. (1996)*". The Himachal Pradesh State Government had leased out a protected forest area on the bank of river Beas to motels, for commercial purposes.

In 1996, the Supreme Court passed a judgment that would hold the State more responsible for maintaining natural resources.

The Right to Pollution Free Environment was declared to be a part of Right to Life under Article 21 of the Constitution of India in the case of "*Subhash Kumar vs. State of Bihar and Ors. (1991)*". Right to Life is a Fundamental Right which includes the Right of enjoyment of pollution free water and air for full enjoyment of life.

14.4 ROLE OF NON-GOVERNMENTAL ORGANIZATIONS (NGOs) IN ENVIRONMENT PROTECTION

Today, we come across various non-governmental organizations whose concerns are focused on various areas such as social issues, health issues, and environmental issues. Non-Governmental Organization (NGO) is a broad term, which includes charity organizations, advisory committees and various other professional organizations. NGOs in India are spread across the country and they have close contacts with communities.

They are involved in the whole spectrum of developmental activities from creating environmental awareness to undertaking watershed development: from disaster management to sustainable livelihoods; from joint forest management to giving inputs to policies. They range from clubs, which encourage nature camping to agencies, which undertake research and monitoring.

There are large number of NGOs in India and other countries that are exclusively working for environmental, protection, conservation, and awareness. The number of these non-governmental organizations which are actively involved in environmental protection in our country is, in fact, more than in any of the developing country. Increasingly, the government is viewing NGOs not only as

agencies that will help them to implement their programs, but also as partners shaping policy and programs.

NGOs are now playing an important role in framing environmental policy, mobilizing public support for environmental conservation, and protecting the endangered species of forests and animals. Environmental organizations such as Earth Watch and Sea Shepherd Conservation Society have been successful in creating awareness about the environmental dangers in using drift nets in the commercial fishing industry.

Through driftnet monitoring, public education and action they were successful in banning driftnet system internationally. The issues like future of environmental protection, sustain-able development and zero population growth are some of the major concerns of the environmental NGOs. Environmental policies will achieve positive results only when they are addressed to local issues and solve the problems of local people. The policy makers should keep in mind the needs of the people while framing the policies and implementing the environment friendly projects.

Unless the needs of the people are identified and supported, sustainable development cannot be achieved. Policymakers and administrators should take care in selecting, financing, and implementing projects, which are aimed at pro-moting social welfare. They should not encourage the enterprises that promote private ownership and cooperation. Some of the international environmental organizations are Greenpeace, Worldwide Fund for Nature' (WWF), Earth First, etc. Let us now have a detailed dis-cussion on some of the environmental organizations and their efforts in protecting environment.

I. Greenpeace

Greenpeace is an environment-friendly international organization, which aims at promoting environmental awareness. It is an independent, campaigning organization, addressing the environmental abuse through direct, non-violent confrontations with governments and companies. It exposes global environmental problems and provides solutions for a healthy environment. Greenpeace focuses on the most crucial worldwide threats to our planets biodiversity and environment. It campaigns to:

1. **Stop Climate Change:** The extensive use of oil, gas, fuel, and other energy resources leads to climatic changes, which results in global warming. In order to stop climate change, Greenpeace is campaigning on various fronts. It has been researching to stop climate change and to promote clean energy solutions.
2. **Protect Ancient Forests:** Many forests of the world are in crisis. The plants and animals are facing the threat of extinction. People living in forests and depend-ing on them for their livelihood are also under threat. Greenpeace takes up the responsibility to save the forests and provides solutions for the same.

3. **Save the Oceans:** Greenpeace's save the oceans campaign currently focuses on four major threats to the world's oceans: overfishing, pirate fishing, whaling, and intensive shrimp aquaculture.
4. **Stop Whaling:** Commercial whaling has resulted in the decline of the world's whale population. In order to stop commercial whaling, Greenpeace is working on many fronts. Through political work public outreach and by adopting non-violent direct action against the whalers at sea. Greenpeace is fighting against commercial whaling.
5. **Say No to Genetic Engineering:** Genetic engineering enables creation of plants, animals and micro-organisms through the manipulation of genes. The organisms, which are produced through genetic engineering when interbred with the natural organisms lead to new environments, which are uncontrolled. Their release into the environment leads to "genetic pollution", as once released they cannot be recalled back. Greenpeace believes that "organisms," which are genetically engineered, should not be released into the environment without adequate knowledge of their impact on the health and environment. It advocates taking immediate measures such as labelling of genetically engineered ingredients, and the segregation of genetically engineered crops from conven-tional ones.
6. **Stop the Nuclear Threat:** Greenpeace campaigns against the use of nuclear power as its use has never been peaceful. It leads to accidents, deaths, and disasters. Radiation released into the environment through the nuclear tests has led to the contamination of soil, air, rivers, and oceans, causing cancer and other diseases in people.
7. **Eliminate Toxic Chemicals:** Greenpeace also campaigns against toxic chemicals, as they prove to be a global threat to the health and environment.
8. **Encourage Sustainable Trade:** Greenpeace opposes the current form of globalization that is increasing corporate power. It demands that the World Trade Organization (WTO) adopt a policy of trade, which works for all and that pre-serves and restores the environment. Governments must work toward achieving sustainable development, which means integrating three things: environmental, social, and economic priorities.

In order to maintain its independence, Greenpeace does not accept funds from governments or from the corporate sector. It has played an important role in preserving the environment, which is proved by its successful achievements:

1. A ban on toxic waste exports to less developed countries.
2. A moratorium on commercial whaling.
3. A United Nations convention providing for better management of world fisheries.
4. A Southern Ocean Whale Sanctuary.

5. A 50-year moratorium on mineral exploitation in Antarctica.
6. Ban on the dumping at sea of radioactive and industrial waste and disused oil installations.
7. An end to high-sea, large-scale driftnet fishing.
8. A ban on all nuclear weapons testing their first ever campaign.

II. World Wide Fund for Nature (WWF)—India

The World Wide Fund for Nature or the WWF is an international organization for wildlife conservation with its focus on protecting particular species of wildlife fauna. As its range of activities broadened, the international organization believed that its name no longer reflected the scope of its activities and it became the Worldwide Fund for Nature in 1986. But the affiliated groups in the United States and Canada retained the original name. The organization is now simply, referred to as the WWF.

WWF-India is committed to protecting and saving the already degraded and threatened natural bounties in the country. The organization is today dedicated to the conservation of natural habitats and ecosystems in India. WWF-India was established as a Charitable Trust in 1969. With its network of State/Divisional and Field Offices spread across the country to implement its programs, WWF-India is the largest and one of the most experienced conservation organizations in the country.

The Secretariat of the organization functions from New Delhi. The organization is part of the WWF family with 27 independent national organizations. The coordinating body, the WWF International, is located at Gland in Switzerland.

In order to suit India's specific ecological and socio-cultural situation, WWF-India articulated its mission in 1987 as follows: "The promotion of nature conservation and environmental protection as the basis for sustainable and equitable development."

The WWF-India Mission has the following broad program components:

1. Promoting India's ecological security; restoring the ecological balance.
2. Conserving biological diversity.
3. Ensuring sustainable use of the natural resource base.
4. Minimizing pollution and wasteful consumption, promoting sustainable lifestyles.

WWF-India implements its conservation programs through Field Programs, Public Policy, Education, Communications, NGO Networking, and Resource Mobilization.

The key environmental issues, which WWF-India has involved itself with, are: The tiger conservation program, fresh-water and wetlands program, river dolphin conservation program, wildlife trade monitoring, managing forests, environmental law, information management and environmental education.

III. Some Other Environmental Organizations in India

Some other environmental organizations in India are as follows:

1. The Bombay Natural History Society (BNHS)

Founded in 1883, the BNHS is recognized as one of the foremost conservation research organizations in the world. It aims to collect data on the specimens on natural history throughout the Indian sub-continent. To disseminate knowledge of flora and fauna by means of lectures, field trips, literature, expeditions and to study wildlife-related problems and recommend management plans to conserve wildlife and its habitat.

It conducts field research projects on bird migration. It also conducts studies of certain endangered species of wildlife and their habitat and through environmental education imparts the knowledge and awareness of the need to conserve wildlife.

It has undertaken a wide range of projects in conjunction with both local and overseas counterpart organizations on birds, reptiles, mammals, natural history, and the impact of developmental programs on wildlife.

2. Development Alternatives Group

Development Alternatives Group based in Delhi works in all parts of the country. It was established in 1983 to design options and promote sustainable development through programs of economic efficiency, equity and social justice, resource conservation, and self-reliance. Its activities cover the entire nation: It is working in the field of pollution monitoring and control, waste recycling management, wasteland development, and appropriate technology. Its objective is to design options and promote sustainable development through programs of:

i. Economic efficiency,
ii. Equity and social justice,
iii. Environmental harmony,
iv. Resource conservation, and
v. Self-reliance.

3. The Energy Research Institute (TERI)

Established in 1974, TERI is a wholly independent, non-profit research institute. Its mission is to develop and promote technologies, policies, and institutions for efficient and sustainable use of natural resources. It has been imparting environmental education through projects, workshops, audio-visual aids, and quiz competitions.

It deals with policy-related works in the energy sector, research on environmental subjects, development of renewable energy technologies and promotion of energy efficiency in the industry and transport sector. TERI also has a major program in biotechnology, the applications of which are oriented toward increased biomass production, conversion of waste into useful products and mitigating the harmful environmental impacts of several economic activities.

TERI established the TERI University in 1998. Initially set up as the TERI School of Advanced Studies, it received the status of a deemed university in 1999. The University is a unique institution of higher learning exclusively for programs leading to PhD and master level degrees. Its uniqueness lies in the wealth of research carried out within TERI as well as by its faculty and students making it a genuinely research oriented university.

14.4.1 Role of Environmental Activities

Environmental activities are those activities which reduce or eliminate pressures on the environment and which aim at making more efficient use of natural resources.

Examples are investing in technologies designed to prevent or reduce pollution, restoring the environment after it has been polluted, protecting the economy from a deteriorated environment, recycling, conservation and resource management and the production of environmental goods and services.

In addition, there are some activities which, though not primarily aimed at protecting the environment, may have environmentally beneficial effects. Damage avoidance and treatment may also be included in the field of interest though these activities are more concerned with rectifying damage already done than with preventing it in the first place.

Lastly, and perhaps less obviously, minimisation of natural hazards may be included although these are activities to protect the economy from the environment where the others are concerned with protecting the environment from the economy.

Check Your Progress

5. Which case introduced the concept of sustainable development in India?
6. When was Development Alternatives Group established?

14.5 ANSWERS TO CHECK YOUR PROGRESS QUESTIONS

1. The phrase ‘enforced by prosecution’ means that the person who is alleged to have committed the offence is formally charged and required to attend court.
2. The first Forest Act of India was enacted in the year 1927.
3. Scheduled Tribes and Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 is an outcome of the struggle by the marginal and tribal communities of our nation to assert their rights over forestland over whom they were conventionally dependent.
4. According to the Wildlife Protection Act 1972, the expression ‘wildlife’ includes any animal, bees, butterflies, fish and moths, and aquatic or land vegetation which forms a part of any habitat.

5. The Bench of Justices PN Bhagwati and Ranganath Mishra in *"Rural Litigation and Entitlement Kendra, Dehradun vs. State of Uttar Pradesh AIR 1987 SC 2187"* introduced the concept of sustainable development.
6. Development Alternatives Group was established in 1983 to design options and promote sustainable development through programs of economic efficiency, equity and social justice, resource conservation, and self-reliance.

14.6 SUMMARY

- Environmental laws are the laws for protecting soil, air, water, the oceans and biodiversity, as well as laws which protect the environment as a whole.
- Common laws are the laws developed by the courts over many years. A criminal law states that to do something is an 'offence' and imposes a fine or a custodial sentence on an offender.
- There are other laws known as Land laws which are enacted to ensure the protection of the rights and resources related to land of the tribal and minority communities.
- As per the Environmental (Protection) Act 1986, the central government is empowered to take all such measures as it deems necessary for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution.
- The Air (Prevention and Control of Pollution) Act, 1981 aims to provide for the prevention and control of air pollution; establish air pollution control boards for carrying out prevention and control of air pollution; and assign functions and confer powers on the boards after establishment.
- Following are the aims of Water (Prevention and Control of Pollution) Act, 1974: i) To provide for the prevention and control of water pollution; ii) To maintain or restore the wholesomeness of water; iii) To establish water pollution control boards for the prevention and control of water pollution; iv) To assign suitable powers and functions for the water pollution control boards.
- The first forest act was enacted in 1927 to strengthen the law related to forests, the transit of forest produce and the duty liable on timber and other forest produce. Subsequently, the Forest (Conservation) Act was promulgated in 1980 to make certain reforms over the proceeding Act of 1927.
- Scheduled Tribes and Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 is an outcome of the struggle by the marginal and tribal communities of our nation to assert their rights over forestland over whom they were conventionally dependent.

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- According to the Wildlife Protection Act, 1972, the expression 'wildlife' includes any animal, bees, butterflies, crustecia, fish and moths, and aquatic or land vegetation which forms part of any habitat.
- The Coastal Regulation Zone Notification 2011 has the following objectives: Conserve and protect coastal stretches, its unique environment and its marine area; Ensure livelihood security to fishermen/other communities living in the coastal areas; Restrict the setting /storage/ disposal of hazardous substances in the CRZ areas
- The Biodiversity Act, 2002 aims to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources.
- Indian heritage and culture has an intimate relation with the conservation and protection of the environment. The Indian State has also enshrined it in the Constitution which requires both the State and the Citizen to "protect and improve the environment".
- The 42nd Amendment to the Constitution of India added Article 48A and 51A(g) which comes under the Directive Principle of State Policy and the Fundamental Duties respectively.
- The Article 48A states: "The State shall endeavour to protect and improve the environment and to safeguard the forest and wildlife of the country."
- The Article 51A(g) imposes a duty upon every citizen of India to protect and improve the natural environment and confers right to come before the Court for appropriate relief.
- Non-Governmental Organization (NGO) is a broad term, which includes charity organizations, advisory committees and various other professional organizations. NGOs in India are spread across the country and they have close contacts with communities.
- NGOs are now playing an important role in framing environmental policy, mobilizing public support for environmental conservation, and protecting the endangered species of forests and animals.
- Greenpeace is an environment-friendly international organization, which aims at promoting environmental awareness. It is an independent, campaigning organization, addressing the environmental abuse through direct, non-violent confrontations with governments and companies.
- In order to maintain its independence, Greenpeace does not accept funds from governments or from the corporate sector.
- The World Wide Fund for Nature or the WWF is an international organization for wildlife conservation with its focus on protecting particular species of wildlife fauna.

- Founded in 1883, the BNHS is recognized as one of the foremost conservation research organizations in the world. It aims to collect data on the specimens on natural history throughout the Indian sub-continent.
- Established in 1974, TERI is a wholly independent, non-profit research institute. Its mission is to develop and promote technologies, policies, and institutions for efficient and sustainable use of natural resources.

14.7 KEY WORDS

- **Whaling:** It is the practice or industry of hunting and killing whales for their oil, meat, or whalebone.
- **Biodiversity:** It refers to the degree of variation of life forms within a given species, ecosystem, biome or an entire planet; a measure of the health of ecosystems.
- **Environmental Laws:** Environmental laws are the laws for protecting soil, air, water, the oceans and biodiversity, as well as laws which protect the environment as a whole. They can protect areas of land or ocean and individual species.
- **Reserve forest:** It is an area of forest set aside and preserved by the government as a wilderness, national park or the like.

14.8 SELF ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the aims of the Water (Prevention and Control of Pollution) Act, 1974?
2. What are the objectives of the Coastal Regulation Zone Notification, 2011? Also mention the classification of CRZ areas.
3. Briefly discuss the salient features of the biodiversity legislation.

Long-Answer Questions

1. Write an essay on the Air (Prevention and Control of Pollution) Act, 1981.
2. Describe some of the major court rulings in India in relation to the environment.
3. Discuss the role of non-governmental organizations in environment protection in India.
4. Explain the major provisions of the Environmental (Protection) Act, 1986.

14.9 FURTHER READINGS

NOTES

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